Telephone Engineer

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Depreciation and Depression There is perhaps no phase of the telephone business about which more has been written than the subject of depreciation. No doubt there will be many more volumes written before any satisfactory conclusion has been reached.

The Interstate Commerce Commission with the unlimited machinery and authority of the United States government behind it has showed its intelligence and at the same time demonstrated its ignorance of the subject of depreciation, after many months of investigation, by postponing from time to time the issuance of any order on depreciation for the use and guidance of the plant accounting department of those engaged in the telephone business. Each time a date was set, some new angle of depreciation was injected into the picture until those who seemed nearest the solution of the knotty problem were almost compelled to confess that, after all, they are only as children playing upon the seashore while the great ocean of truth still lies undiscovered before them.

The difficulties of the investigating body have been numerous and are too well known to those engaged in the telephone business to call for a lengthy rehearsal here. They are chiefly concerned with types of equipment, character of construction and number of subscribers served from a given exchange center and location. Since each of these is subject to many variations, it is little wonder that direct orders have been slow in coming and any general order that is entered in the future will of necessity be subject to attack and change as experience may dictate.

Based on the reports of the eighty-two Class A telephone companies reporting to the Interstate Commerce Commission for last year, the average charge for depreciation was three and six-tenths per cent. The highest rate charged by any company was eight and six-tenths per cent and the lowest was six-tenths per cent.

In our way of thinking, any reasonable composite rate, whether it be four, five, six, or even seven per cent can be so applied as to largely impair the very purpose for which it was intended. We have always looked upon a depreciation reserve, properly applied, as a wall of protection to the public served and at the same time a guard of safety to the stockholder who has invested his money in telephone securities. Now that we are passing through one of the most crucial tests the telephone business has been called upon to experience in its comparatively short life, there will be a strong temptation on the part of some to maintain dividend rates at the expense of depreciation by shifting ordinary maintenance to depreciation and in this way have a larger balance for interest and dividends. Since it will be some time before reports for the current year are available, we feel that we cannot be criticized for saying that we will be interested in noting how many companies have met the situation squarely and reduced their dividend rate and how many others have maintained their dividend rate at the expense of depreciation.

No doubt it took a great deal of courage on the part of the Western Electric company when they announced recently that the quarterly dividend rate would be omitted and while at first thought we had a feeling that this great business organization was weakening, we saw upon further reflection that it was doing the very thing any sensible body of men should do to preserve a necessary and useful enterprise.

All the above, however, is only by way of introduction to the thought we have in mind and that is the lesson we may learn from present and past experience. It was the immortal Patrick Henry who said: "There is no way of judging the future except by the past," and judging by the past, there will be other fat periods and other lean periods in the years to come as there have been in the years that are past.

Then why should not the telephone companies and other public utilities fortify themselves against the periods of depression, when times are good, by setting aside a depreciation reserve in cash, and by building up a surplus in cash, so as to preserve an unbroken record of performance in the payment of

dividends regardless of conditions? There are few companies in the public utility field that were properly financed to begin with that could not have done this by following a more conservative policy when times were good. A depreciation reserve in actual cash in addition to the book reserve carried by most companies and a reasonable cash surplus would serve as stabilizers in times of stress such as could not be obtained in any other way. We might look to the example set by the city of Milwaukee. With a cash surplus of more than $5,000,000.00, she is able this year to defer the taxes due from her citizens without any embarrassment to the treasury in any way.

It was the lamented Jim Kelsey who, many years ago, preached the doctrine of a cash depreciation reserve for telephone companies. It was in a day when depreciation as applied at the present time was an unknown quantity. Kelsey would say to the smaller exchange owner, "It isn't enough, but if you will set aside in cash the sum of $1.00 per telephone per year as a depreciation reserve and in addition to this, maintain your plant to a reasonable degree of efficiency, you will never have any financial difficulties on account of necessary replacements."

We are wondering right now what would have been the result if the large exchange owners, as well as the small ones, had pursued this policy during the last ten years and set aside $1.00 in cash, per telephone, each year as a part of the regular book reserve. Just take your pencil and figure it out for yourself and see where it would place you as compared with your present circumstances. There is no doubt but that the results will be surprising. If handled in this way we have replaced an intangible with something that is tangible without taking away from the engineers and accountants any of the glory that may be theirs in having built up the present standards from zero to a figure which for the Class A companies alone amounts to more than thirty-eight million dollars.

After all, the only actual test of depreciation is the human eye. The law of averages as applied to the telephone business is only to be depended upon when the eye and the judgment have inspected and analyzed every item of plant value and the total value of all units of a given kind and degree of depreciation and obsolescence, divided by the total number of units, and even then the figures obtained will only hold good until after the next storm.

In addition to all the other conditions that affect plant values, there is now a new situation gradually developing. The practice of basing plant values on the original cost new less depreciation and using the cost new as a basis for rate making has become pretty general. But just now there is a feeling on the part of some governing bodies that a telephone plant has but one value whether for the purpose of capitalization, taxation or rate making, and that value is the cost new less depreciation.

Then there is the further danger that governing bodies may conceive the notion that values should be based on the present cost new less depreciation. If this principle were established at this time it would have a devastating effect on the book values of most telephone companies. While there is little danger from this source right now, if present low prices of materials and labor should continue over a period of years, with further reductions in prospect, then what is now a probability can easily become a possibility and it is not too early for the telephone companies to prepare themselves to meet the situation, and if they have been wrong in their contentions, get themselves right before they are forced to do so.

Putting Sales in Salesmanship

The following story of super-salesmanship appeared in a recent issue of a metropolitan newspaper. A young man was arrested for speeding. At his trial he gave as his defense the fact that he had just installed a new gadget on his car and that it had worked so well he was not conscious of his speed. His excuse and description of the device so impressed the judge and the arresting officer that they both purchased (from the young man) attachments for their cars. The speeding charge was dismissed!

Whether true or not, the story illustrates some important angles of the selling game. First, the young man was not easily discouraged. Second, he grasped unexpected opportunities. Third, he talked convincingly. The result was two unlooked-for sales, relief from an embarrassing situation, and mutual satisfaction.

Selling service is an important part of our jobs as telephone men and women. In fact, employee sales have become the keystone of our sales program. If we will but remember this story and apply its lessons practically our sales will multiply. Do not be discouraged by lost prospects. Increase your contacts. If you talk to more people you'll sell more people. Don't pass the unlikely customer. He might surprise you and be easily sold. Talk convincingly, paint your picture attractively, describe honestly what the service will do. Size up your prospect. Some buy to increase the comfort and convenience of their daily lives, others in order to make more money, still others as a means of economy in their business. Apply appropriate sales talks.

These methods are not new but they are effective and if used properly and with judgment will undoubtedly put more sales in your salesmanship.—Indiana Telephone News.

Announce Plans for National Convention

Divisions of Association Will Meet to Discuss Problems Pertinent to Their Own Work; Well Known Economists and Telephone Authorities Will Address Various Meetings; Third Day to Be Given Over to Pioneers' Association

In this issue of TELEPHONE ENGINEER we publish the program for the thirty-fifth annual convention of the United States Independent Telephone association, which will be held at the Hotel Stevens, Chicago, October 20th to 23rd.

It is evident from the program that the sessions this year are to be business sessions. Beginning with the Commercial division's discussion of the "Net Results of Sales Campaigns" on the first afteroon, and concluding with the conference of Class A, B and C companies, there are discussions and addresses scheduled covering most of the commercial features of the telephone industry.

Of special interest will be the two addresses on the morning of Wednesday, the 21st, one by Dr. David Friday, well known economist, of Washington, D. C., on the "Future of Industry," and the other by Professor R. E. Pattison Kline, of Chicago, on "America in a World Neighborhood." The reports by the officers of the association no doubt will call attention to the problems of the industry and fit well into this business program.

It is evident, however, that notwithstanding that the general session discussions are to be on Commercial division problems, the other divisions of the association will be holding interesting conferences on their own special matters. This year the Accounting, Traffic and Program Service divisions are to have breakfast and luncheon conferences, reviving a procedure that met with a great deal of favor three years ago when the breakfast and luncheon method of getting together was part of the national association's program.

The Plant division has scheduled for an afternoon conference two most interesting discussions—one by Ray H. Manson, chief engineer, Stromberg-Carlson Telephone Manufacturing company, Rochester, New York, on the "Relation of Radio to Telephony," and the other by A. L. Stadermann, chairman of the association's Plant division, on the new standard specifications for wood poles, with a related discussion of pole line engineering.

As usual, the third day of the convention will be given over to the annual meeting and annual luncheon and entertainment of the Pioneers' association.

Manufacturers and distributors of equipment have reserved space on the exhibit floor and are promising something unusual in the way of exhibits that will attract every telephone man interested in new equipment and new methods of construction.

The association is sending out a letter this week advising its members to come early and stay late and promising them a meeting of exceptional interest. The association has also extended an invitation to all of the Independent companies, whether members or not. With the many problems that are facing the companies, including that of the desirability of a closer relationship between telegraph and telephone companies, no manager can afford to miss this get-together meeting and get the view of the "other fellow" on these questions.

VACUUM TUBE THEORY AND PRACTICE

SUBJECT: SOUND PROJECTION PRACTICE

General

In addition to the important role the vacuum tube plays in the modern radio, it is also the keystone of a comparatively new art which might properly be called "Sound Projection."

We may classify the various types of sound projection work into four general heads as follows:

1. Public Address Systems.
2. Talking Picture Installations.
3. Program Service Systems.
4. Program Pick Up Work.

Public address, program service, and program pick up installations are logical by-products of the telephone business. Many progressive telephone companies over the country who early recognized the revenue possibilities, have for a number of years been selling public address service, and some companies have been very successful in utilizing spare cable plant for distributing radio programs to subscribers.

Power companies have not hesitated in offering washing machines, electric refrigerators, and radios to their customers. These items are sold at a profit and in addition help build up the power load.

Telephone companies should follow the example set by the power folks, and sell public address installations, program pick up, and other kindred services.

This article is the first of a series covering the theory and application of sound projection practices with special reference to public address, program pick up, and program supply services.

General Features of Public Address Work

The term "Public Address System" refers to an arrangement of microphones, amplifiers and projectors (loud speakers) used to raise the volume level of voice or music so that it may be heard by a group of people assembled together either indoors or out in the open.

Such systems may be operated either with the pick up microphone located in the immediate vicinity of the projectors or with it located a considerable distance away and connected to the projectors by means of cable pairs and in some cases toll lines.

The essential elements of any public address system are the input microphone, microphone amplifier, power amplifier, level indicator, power source, and projectors.

The chief difference between small and large systems is in the size of the amplifying tubes and power supply used.

The power output required for a given job depends in general on the size of the crowd to be covered, and on the acoustics

of the space into which the sound is projected.

Public address loud speakers will project sound to cover a definite angle, in front of the speaker, and one of the principal problems in engineering an installation is how to arrange the various projectors so as to give maximum coverage with a minimum of distortion.

Public address installations in buildings often encounter severe difficulties due to poor building acoustics, whereas outside installation, while usually free from this type of trouble, may often prove difficult due to wind or noise conditions.

It was formerly the practice to use batteries for plate and filament supply, but the present trend is towards the use of a. c. operated systems. This has greatly simplified installation work.

Acoustic Data

The successful operation of an indoor public address installation depends in a large part upon the acoustics of the building in which an installation is made.

It is therefore highly important that a proper understanding of theory of acoustics be had by those engaged in sound projection work.

The following paragraphs discuss in a general way the basic facts regarding acoustics.

When a sound is made at a certain point in a room, sound waves are radiated from this point in all directions at a speed of approximately 1,100 feet per second.

In the average auditorium the walls, ceiling and floor are seldom over a few hundred feet away from the sound source, hence the radiated sounds reach these surfaces in a small fraction of a second.

The sound waves, on striking these surfaces, are either absorbed or reflected back into the room, depending upon the absorption qualities of the surfaces which they strike.

This action is analogous to throwing a ball against a hard surface which would cause the ball to bounce up and down several times before it finally comes to rest, whereas when thrown against a soft or absorbing surface it would bounce but little if at all.

The effect of the reflecting action of non-absorbent surfaces is to cause the original sound wave to bound from one reflecting surface to another until it is finally dissipated. If the reflecting surfaces were very efficient as a reflecting medium then the reflected sound wave may be audible for several seconds after the original source had ceased.

The reflected waves passing back and forth between non-absorbing surfaces are heard by the listener as a "lingering sound," and if the duration of the initial sound is short and the reflection is high, the sound will be heard as a distant echo.

The effects of reflection just described are termed "reverberation."

It should be understood that echo and reverberation are the same except that echo refers to a sharp, distinct repetition of sound, whereas reverberation is merely a lingering trail of sound which accompanies and follows the initial sound.

"Echo effects" result principally where the reflecting surface is a considerable distance from the sound source, so that the sound waves require an appreciable time to reach the reflecting surface and then be reflected back to the sound source. The length of time a sound persists after the source has ceased, is known as the "period of reverberation."

For example, a room in which sound could be heard four seconds after the source had stopped would be said to have a period of reverberation of four seconds.

The period of reverberation of rooms is used as one of the factors in computing and correcting acoustical conditions.

It is evident that in rooms having high periods of reverberation that a listener will hear both the original and reflected waves at the same time and speech will be unintelligible.

At first thought it would seem that a room having zero reflection would be ideal for auditorium purposes. On the contrary, it has been found that a small amount of reflection is desirable. A room which is highly absorbent to sound will sound dead and the voice or music will lack color.

The optimum period of reverberation for rooms used for auditorium purposes varies with the volume of the room. The following table gives optimum periods of reverberation for various size auditoriums.

Optimum Periods of Reverberation

Note.—The following table is prepared from published data compiled by Professor F. R. Watson.

Volume	Seconds
Below 7,000 cubic feet	1.0
7,000 to 20,000 cubic feet	1.1
20,000 to 45,000 cubic feet	1.2
45,000 to 85,000 cubic feet	1.3
85,000 to 145,000 cubic feet	1.4
145,000 to 225,000 cubic feet	1.5
225,000 to 330,000 cubic feet	1.6
330,000 to 465,000 cubic feet	1.7
465,000 to 630,000 cubic feet	1.8
630,000 to 835,000 cubic feet	1.9
835,000 to 1,100,000 cubic feet	2.0

It will be noted that the smaller the auditorium the smaller the optimum period of reverberation.

Computation of Room Acoustics

An impirical formula which permits evaluating the period of reverberation of rooms was worked out by Sabine and is as follows:

$$t = \frac{0.05 \times \text{volume}}{a}$$

Where: t = period of vibration in seconds; volume = entire volume in cubic feet; a = number of units of absorption present in the room.

In order to have some basis for computing reflection effects Professor Sabine of Harvard, assigned coefficients of absorption to the various materials usually present in rooms.

The coefficients were based on a large number of tests using a standard sound having a pitch of 512 vibrations per second.

It will be noted that the *unit of absorption* has been taken as the absorbing power of a window opening one foot square. Obviously an open window has perfect absorbing power as all the sound striking it passes on through and there is no reflected wave.

The following table of coefficients of absorption is commonly used in connection with acoustical computations.

Coefficients of Absorption

Note.—The following coefficients are taken from the published works and test data of Professor Wallace C. Sabine and Professor F. R. Watson. They are for the standard pitch of 512 vibrations per second.

Material	Units per Sq. Ft.
Open window	1.00
Plaster	.025 to .034
Concrete	.015
Brick set in Portland cement	.025
Marble	.01
Glass, single thickness	.027
Wood sheathing	.061
Wood, varnished	.03
Cork tile	.03
Linoleum	.03
Carpets	.15 to .29
Cretonne cloth	.15
Curtains in heavy folds	.50 to 1.00
Hairfelt, 1", with painted membrane	.25 to .45
Acousti-Celotex, Type BB, painted or unpainted	.70
Acousti-Celotex, Type B, painted or unpainted	.47
Acousti-Celotex, Type C, painted or unpainted	.30
Acousti-Celotex, Type A, unpainted	.25
Individual Objects	
Audience per person	4.7
Church pews, per seat	.2
Wood seats for auditoriums, per seat	.1
Upholstered seats, per seat	1.0 to 2.5
Pew cushion, per seat	1.45 to 2.04

Referring to the above table it will be seen that hard surfaces such as plaster, concrete, glass, wood, etc., have very low sound absorbing properties, whereas carpets, curtains and special acoustic material have high absorption values.

In computing the period of a room it

(*Continued on Page* 60)

Elementary Course in Telephone Practice

The Student May Test His Knowledge Thoroughly in This Sixth Chapter of an Elementary Course in the Study of the Telephone by O. B. Fensholt, Wherein the Author Gives Problems Dealing with Combination Circuits, Telephones, and Wire Sizes

Problems—Combination Circuits

Before we do any problems in combination circuits, let us remember that:

1. Electricity can only flow one way through a conductor at one time.

2. There will be a voltage drop in the

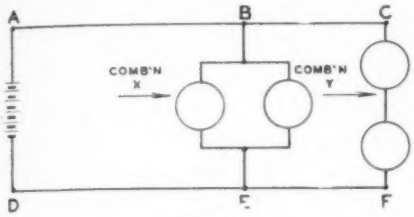


Fig. 23

wires if a resistance is shown for those wires.

3. When you find the current, begin with the part farthest from the battery or generator.

4. When applying Ohms law to any part of a circuit that you must know two things at that same part to find the third or unknown. That is: To find the volts one place, you must know the ohms and the amperes at the same place.

Problems

Let Fig. 23 represent a combination of parallel and series circuits.

1. Let each resistance take 0.5 ampere.

What will be the current for the combination X? What will be the current for the combination Y?

2. If each resistance in Fig. 23 has 200 ohms, what will be the resistance of each combination X and Y? What will be the total resistance of both combinations?

3. If the battery of Fig. 23 has a

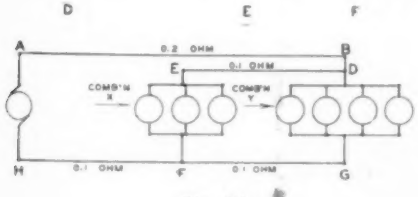


Fig. 24

pressure of 50 volts, each resistance has 200 ohms, and each line wire—that is, wires AB, BC, DE and EF—has 0.2 ohm each, what will be the total current of the circuit?

4. If the current of each lamp in Fig. 24 is 1.1 amperes and the generator has a pressure of 110 volts, what will be the pressure across combination X and Y?

5. If we did not know the pressure of the generator, but knew there were 100 volts across combination Y, in Fig. 24, and each lamp took 1.1 amperes, what would the pressure be at combination X and at the generator?

6. What is the resistance of each lamp in combination X, problem 5? What is the total resistance of problem 5?

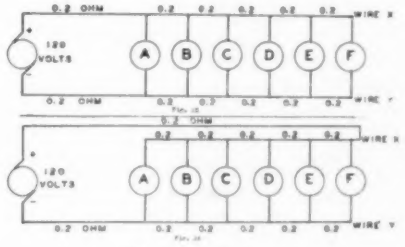
7. Let each lamp in Fig. 25 take 1.2 amperes. The generator voltage is 120 volts. The resistance of each line wire is 0.2 ohm. Find:

(a) The amount of current in each section of wire.

(b) The voltage across each lamp

(c) The voltage drop across each lamp.

8. Let Fig. 26 represent the same lamps and wires, except that the positive connection is connected to the right hand side of line X and the negative is connected to the left hand side of line Y. Each lamp still has 1.2 amperes through it, and each section of line wire has 0.2 ohm resistance. Find the same as asked in questions (a), (b) and (c) of problem 7.



Figs. 25 and 26

9. Let Fig. 27 represent the same lamps and wires again as problems 7 and 8, but this time the generator feeds the circuit from the center. Again find the same as asked for in problem 7.

Telephone Problems

Note: The figures used in these problems are not to be taken as actual figures, but have just been taken to make up problems.

1. If a telephone ringer has two coils of 700 ohms each, how much current will flow if it takes a pressure of 110 volts to ring the bell?

2. If a line relay will operate between 75 to 150 milliamperes, will this relay operate at 24 volts, and if a 6,000 ohm coil is placed in series with the ringer of problem 1? What would be the current of this circuit?

3. How much resistance could be added to a 1400 ohm ringer to bring the current down to 75 milliamperes, at 24 volts?

4. If a ringer circuit has a ringer of 1,000 ohms, in series with a 3,000 ohm coil, and then we put a 48,000 ohm coil in parallel with the ringer and 3,000 ohm coil, what will be the resistance of the combination?

5. If a transmitter has a resistance of

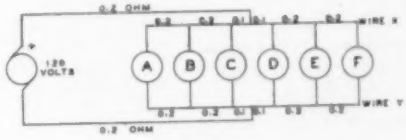


Fig. 27

40 ohms, a primary coil has 17 ohms, and the resistance of each line wire from the central office battery to instrument is 43 ohms, what current will flow if the switchhook is up and the central office battery has 24 volts?

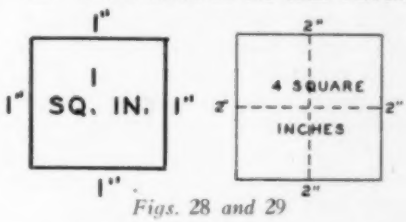
6. If a receiver circuit consists of a secondary coil of 26 ohms, a transmitter of 40 ohms, and a receiver of 70 ohms, what would be the total resistance of the receiver circuit?

7. If a central office relay has one winding resistance of 800 ohms, and a shunt winding of 40 ohms, what will be the total resistance of the parallel combination of the relay?

8. If the total resistance of a subscriber's instrument is 48 ohms, what would be the total resistance of a 4 party line? (Do not consider resistance in the line wires.)

9. What would be the total resistance of a telephone circuit from the central office as problem 8, if each line wire between subscribers had a resistance of 2.5 ohms, and the resistance of each line wire from the central office to the nearest subscriber was 30.4 ohms?

10. What would be the total current



Figs. 28 and 29

in problem 9, if the central office battery has a pressure of 24 volts? What would be the current at subscribers 1, 2, 3, and 4?

11. If a ringer had a resistance of 1,000 ohms, and 24 volts were placed on

it, what would be the current? If another subscriber (1,000 ohm ringer) were added, how much current would now flow at 24 volts?

12. If an instrument is connected to a line, and each line wire has 42.8 ohms, the ringer has 1,000 ohms, and a 6,000 ohm coil is connected in series, what

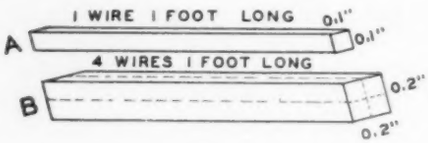


Fig. 30

would be the current if 24 volts were put in this circuit?

13. What would be the current in problem 12 if the switch hook is raised, putting your transmitter circuit as a shunt across the ringer? Figure transmitter circuit as a primary winding of 14 ohms and a transmitter of 37 ohms.

14. What is the resistance of the primary circuit of a local battery instrument, with a coil of 1.8 ohms and a transmitter of 36.4 ohms?

15. What would be the current flow in problem 14, when two dry cells are connected to this circuit? (Each battery to have 1.5 volts.)

Wire Sizes

We have already said that we can vary an electric current by varying the resistance, and we also said that this resistance can be varied by the length of our conductors, also the thickness or the diameter of our conductors varies the resistance. It will therefore be necessary that we know something about wire sizes.

We previously said that the standard for one ohm resistance was a No. 10 copper wire, 1,000 feet long. This No. 10 wire is 1/10 of an inch in diameter.

By explaining series circuits, you can readily understand that as the wire gets longer the resistance gets greater.

It is a little more difficult to understand, though, that as the wire diameter gets larger, that the resistance gets less. This is because we confuse the large end surface of a wire as though it would "block" the current, but if you will picture the end area of a wire as an opening, you can see that the larger the wire the larger would be your opening or the less would be the resistance. Also we might say that it is like adding more wires in parallel, and we know that the rules for ohms of a parallel combination is less than its smallest branch.

In order to explain this a little more clearly let us assume that all conductors are square instead of round.

If we have a square wire, as shown by Fig. 28, with one inch on each side, we know that we will have an end area of 1x1 or one inch square inch.

Should we take a wire that is twice as large on each side or two inches on a side, we would then have an end area of 2x2, or four square inches. You will notice that a two-inch wire has four times the area of a one-inch wire, which is shown by Fig. 29.

We are then increasing the size of the side of a square wire, the square of one side. That is, a three-inch wire would be 3^2 or 3x3 or nine times as large as a one-inch wire, and a five-inch wire would be 5^2 or 5x5 or 25 times as large as a one-inch wire, and so on.

If we have a square wire $\frac{1}{10}$ of an inch on a side, we will have an end area of $(\frac{1}{10})^2$ or $\frac{1}{10} \times \frac{1}{10}$, which would be $\frac{1 \times 1}{10 \times 10}$ or $\frac{1}{100}$ square inches. By using decimals in place of fractions it would be 0.1^2 or $0.1 \times 0.1 = .01$ square inch.

To simplify our case, let us assume that a square wire 1/10 of an inch on a side, and one foot long, has a resistance of one ohm. Then let us take a square

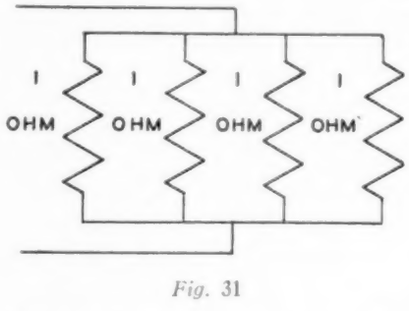


Fig. 31

wire 2/10 of an inch on a side, and find the resistance of one foot of this wire. We know that a wire 2/10 of an inch on a side is four times as large as a wire 1/10 of an inch on a side, or will be equal to four 1/10 of an inch wires in parallel, as shown in Fig. 30. Therefore, if the size is four times as large, the resistance will only be 1/4 as much, or .25 ohm.

We will now prove this by applying Ohm's law, and referring to Fig. 31.

We first had one wire with one ohm resistance, and then we added three more wires, of one ohm each, in parallel. We have proven that the combined resistance of a parallel combination is less than the resistance of its smallest branch, which in this case is one ohm. So it will have to be less than one ohm.

Now, by using Ohm's law, and apply the conductance method, the conductance or amperes of the combined circuit will be 1/1 + 1/1 + 1/1 + 1/1 or 1 + 1 + 1 + 1 = 4 amperes per volt. The resistance will then be $(O = \frac{V}{A})$. One volt (assumed) divided by four amperes, the conductance will equal 1/4 or .25 ohm.

This, therefore, proves by Ohm's law that as the wire gets larger the resistance gets less. Keep in mind that as pipes get larger the resistance to water gets less, and use this as a comparison to electricity.

Wire Sizes—Circular

We have just explained how the size of a square wire equals the "square" of its side.

The wires we deal with in telephony are round or circular, therefore we must be able to compute the resistance of round wire.

The statements we made about square wires also hold true about round or circular wires. That is, if we know the resistance of one foot of any size wire we can find the resistance of any length of that wire by multiplying the resistance of that one foot by the number of feet. Also, if we have a wire 4 inches in diameter it is equal to 4x4 or 16 one-inch wires, the same as with a square wire. This is a little harder to see with round wire, so we will make a diagram illustrating it.

In Fig. 32, let A represent the end of a 1-inch wire, and let B represent a 3-inch wire, and C a 4-inch wire. If we could cut off the portions of the wire outside of the large circle in B, we could use this to fill up the spaces between the small wires within the large circle, or it would be equal to one large wire. Therefore, a 3-inch wire would be the same as 3x3 or 9 1-inch wires. This you can see also holds true for a 4-inch wire, etc.

Normally we do not deal with wires one inch in diameter for telephone work. Our wires are a great deal smaller; so we will use a measurement which is smaller than inches. Since we want something very small, let us use a unit of 1/1000 of an inch in diameter.

We know that the term milliampere

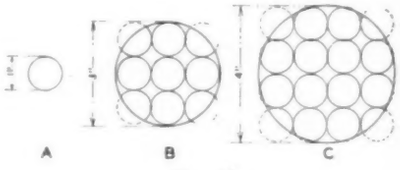


Fig. 32

means 1/1000 of an ampere. Then let us use the word "milli-inch," to mean 1/1000 of an inch.

In one of our first lessons we said we would abbreviate or use short terms, or shorthand. Then, instead of saying "milli-inch," let us say "mil." That is, mil means 1/1000 of an inch. A wire of 48 mils diameter would be 48/1000 or .048 of an inch in diameter. A wire of 376 mils would be 376/1000 or .376 of an inch in diameter, etc.

This term mil can be divided into two sections, "circular mil" and "square mil."

The only difference would be one would be a round wire and the other a square wire. Then, if we say one wire contains 37 square mils, and another contains 37 circular mils, we know that the first is a square wire equal to 37 square wires 1/1000 of an inch square, and the second wire is a round wire equal to 37 wires 1/1000 of an inch in diameter.

We said that a wire 1,000 feet long and 1/10 of an inch in diameter has 1 ohm resistance; that is, a wire 1,000 feet long and .100 of an inch or 100 mils is one ohm.

You will notice that we are dealing with length, so we will use another term for both length and size. Our wire size is "mil," our length is "foot." We will therefore use the term "mil-foot," which will mean a wire one mil in area and one foot long. A 10 mil-foot wire would be 10 mils in area and 1 foot long. You will notice that it is always one foot long, but that the area changes. Then, if we can find the resistance of a one mil foot wire, we can find the resistance of any size and of any length wire. That is, the resistance will get less as the mils (wire size) gets larger, but the resistance will get greater as the wire gets longer. You can see that in the first case we are adding wires in parallel, while in the length they are in series.

To find the resistance of a certain size wire of any length:

Divide the resistance of 1 mil foot of that wire by the number of mil foot wires (circular mil area) and multiply by the number of feet length of that wire, or our formula would be like this:

$$\text{The total resistance of the wire} = \frac{\text{Res per Mil-foot}}{\text{Area (Mils)}} \times \text{length in feet.}$$

Problems—Wire Sizes

1. What part of an inch is 1 mil equal to?
2. How many mils in 0.382 inch?
3. How many mils in 0.084 inch?
4. A wire has a diameter of 1.3 inch. What is the dieameter in mils?
5. A wire with a diameter of ¼-inch is equal to how many mils?
6. What is the size in inches of a wire whose diameter is 65 mils?
7. What is the square mil area of a wire 3 mils on a side?
8. What is the square mill area of a wire 1/10 of an inch on each side?
9. What will be the circular mil area of a wire 0.029 inches in diameter.
10. If a wire has a diameter of ¼ inch, what will be the circular mil area?

(Note: The average resistance of copper wire at 68° F. is equal to about 10.7 ohms per mil foot. Use this figure for the following problems.)

11. If a copper wire has a diameter of 5/100 inch, what will be the resistance of 900 feet of this wire?
12. If a No. 22 gauge wire has a diameter of 25.4 mils, what will be the resistance of 2 miles of this wire?
13. What is the resistance of a pair of wires 500 feet long, and of 325 circular mil area?
14. If a copper wire has a resistance of 2 ohms, and is .05 inch in diameter, what will be the length?
15. If a wire has an area of 400 circular mils, what will be the diameter in mils?
16. What will be the diameter of the wire of problem 15 in inches?
17. How many miles of copper wire 500 mils in diameter will it take to make 2 ohms resistance?
18. A telephone is 4 miles from the central office and No. 22 gauge cable is used (25.4 mil diameter). What will be the resistance of this line?
19. If 500 feet of 24 gauge wire (20 mil diameter) were added in the central office to problem 18, what would be the total resistance?
20. What is the resistance of the wire in the central office in problem 19?

TELEPHONE OFFICIAL SEES BUSINESS UPTURN

A "slow but sure upward trend" in business is predicted by Gen. George S. Gibbs, vice-president of the International Telephone & Telegraph corporation, following a personal survey of conditions in 32 American cities.

The survey convinced Mr. Gibbs that "depression is in part manufactured in New York" and that it has little basis in actual conditions save in isolated instances. Pittsburgh and Detroit, Mr. Gibbs said, were the only cities outside of New York where optimism has not begun to reassert itself.

He summed up the view of "leading bankers and business men of 30 out of the 32 cities visited" as follows:

"Business is not good. We are running a little behind last year. But we are in sound condition—well able to take care of any of our victims of the depression, and we will need no outside assistance. Our city seems to be in splendid shape, considering the situation in other communities."

Mr. Gibbs said that in many of the cities the depression was known only "by hearsay."

"In other words, New York has informed them that a depression is on," Mr. Gibbs asserted. "So they think there must be one, but it is always 'somewhere else'."

Mr. Gibbs found those cities dependent upon steel or automobile manufacturing in worse straits than those relying upon more diversified industries, or those which are more purely distributing centers.

He said conditions in Atlanta, Charlotte, N. C., Omaha, Denver, and Cleveland were "surprisingly sound." He was impressed by the tone of confidence in large retail distribution centers such as Minneapolis and Dallas.

Mr. Gibbs made the tour in order to familiarize himself with the different communication services controlled by the company he became connected with immediately following his retirement from the Signal Corps last July.

Cities included in the tour were Pittsburgh, Cleveland, Akron, O., Detroit, Chicago, St. Louis, Minneapolis, St. Paul, Kansas City, Omaha, Cheyenne, Denver, Boise City, Salt Lake City, Portland, Ore., Seattle, San Francisco, Los Angeles, El Paso, Dallas, San Antonio, Houston, Galveston, New Orleans, Birmingham, Charlotte, Richmond, Washington and Baltimore.

MORRISTOWN EXCHANGE GIVES SUPERSERVICE

In the September TELEPHONE ENGINEER on the page of "Telephone News from the Southwest" there appeared a paragraph concerning an operator at Elk City, Okla., who kept a list of names of persons who attempted to telephone a physician's office during a fifteen-minute period which found both the physician and his assistant absent from the doctor's office.

In response to this item, Henry Seidel, secretary and manager of the Morristown Telephone company, Morristown, Minn., writes TELEPHONE ENGINEER that such service is customary at the Morristown exchange. He tells that not only does the operator keep a list of calls for the city's only physician, but usually is informed by him before he leaves his offices where he can be located, and in case of an emergency or hurry call she will get in touch with the doctor and tell him where he is needed.

H. E. SHOTTS NEW HEAD OF STANDARD SERVICE

At a recent meeting of the board of directors of the Standard Public Service company, at Columbus, Ohio, H. E. Shotts was elected president to succeed Mr. Shoemaker, who resigned recently. The Standard Public Service company operates approximately 47,000 stations through subsidiaries in Kentucky, Ohio, Indiana, Illinois, Iowa, Missouri, Oklahoma and Texas. In addition, the company owns a number of water works plants.

For several years Mr. Shotts has been a director of the Standard company, and has been for many years identified with E. H. Rollins & Sons, Inc., nationally known investment bankers. Previously he was engaged in consulting engineering practice in connection with municipal and utility works.

Telephone Activities in Foreign Countries

Dispatches from Abroad Keep Telephone Men in United States Constantly Informed Concerning Telephony of the World; Domestic Telephone Problems Oftentimes Can Be at Least Partially Solved by Watching the Outcome of Experiments Made Elsewhere

Plan Ship-to-Shore Telephone in Sweden

The Swedish-American line, Goteborg, plans installing wireless telephone equipment on its passenger steamers. The wireless telephone already has been used to a considerable extent in Sweden for maintaining contact with vessels in the Baltic. For this particular purpose there are stations in Boden, Harnosand, Vaxholm and Karlskona. The coast guard service of Sweden has installed connections between the lightships and the mainland.

Projected Telephone Line from Greece to Turkey

A project for the extension of the Athens-Saloniki telephone line to Istanbul, Turkey, is in course of discussion by the Greek Ministry of Communications. At the present time the only long distance international telephone line from Saloniki is that which extends from Skoplje and Belgrade in Yugoslavia.

Rumanian 'Phone Service Improved Under American Management

In the short time since the administration and operation of the Rumanian telephone system was taken over by an American company in January of this year service has been improved manyfold. Both local and interurban calls have been greatly speeded up and the improved apparatus and modern technic are already apparent in the more efficient handling of all matters. Excavations are about finished in preparation for the construction of the modern 13-story administration and exchange building. It is expected to complete this work in 1932 as well as considerable other similar construction work in various parts of the country.

Introduction of international communication has been one of the main features of the telephone company's work up to the present.

Telephone Communications Open Between Belgium and Siam

The Ministry of Posts, Telegraphs and Telephones has announced that direct telephone service has been formally opened between any part of Belgium and Bangkok, Siam.

Telephone Service Between North America and Canary Islands

Radio-telephone service was extended recently from North America to the Canary Islands, the last outpost of the old world touched by Columbus on his voyage of discovery.

Calls will proceed from the United States via London and Madrid and thence to the island group off the west coast of Africa, slightly south of Morocco. This service extension to the Canary Islands was made possible by the opening of radio telephone service from Madrid to Santa Cruz, on the island of Tenerife in the Canaries, early this year. A forty-mile submarine cable, which carries calls to Las Palmas on the island of Gran Canaria, makes it possible to reach telephones on the principal islands in the Canaries. In all, there are some 2,500 telephones available.

Radio-Telephone Service Between Great Britain and New Zealand

A radio-telephone service has been inaugurated between all parts of Great Britain and Northern Ireland and all parts of New Zealand. As the transmitting radio section in New Zealand is not sufficiently powerful to communicate directly with Great Britain, calls in the new service will be set up by connecting at Sydney the radio-telephone circuit between Great Britain and Australia and that between Australia and New Zealand.

New Site of Trans-Atlantic Station in Scotland

The trans-Atlantic wireless station which was erected four years ago at Kemback, Fifeshire, is to be moved to a new site near Cupar, Fifeshire. The present station was an experimental one and was of a temporary nature. The station was so successful, however, that it has been decided to build a permanent station to handle wireless telephonic communication with the American continent, and new and improved apparatus is to be installed. It is understood that work on this new station will be begun in two months.

Extend Australian Long Distance Telephone Service

Improvements are being made in the long distance telephone service in Victoria, making it possible for subscribers in many country towns to obtain the trunk line service from their own telephones. On October 1 the following towns were to be included in this service: Ballarat, Bacchus Marsh, Belgrave, Bendigo, Ferntree Gully, Geelong, Seymour, Upper Macedon, Warburton and Warragul.

Long Distance Telephone Service Between Canton and Hong Kong

Long distance telephone service between Canton and Hong Kong, China, was inaugurated in September, according to a radiogram from Commercial Attache Julean Arnold, of Shanghai.

Plan Use of Telephones on British Trains

While no actual service has been inaugurated, the London & North Eastern railway has been satisfactorily conducting a series of experiments which it is hoped will enable passengers on long distance trains traveling at high speed to talk with any telephone subscriber in the country. The railway company's engineers are attacking the problem of the busy business man who on such a run as the London to Edinburgh, about 395 miles, is virtually isolated from his office for hours at a time. It is hoped before long to develop a regular service.

A further use to which they plan to put the telephone is for communication between the engineer and the conductor from various parts of the train. It is thought that this would be particularly useful on long runs, and that it may work out in time to be a considerable safety measure.

Announce Lowering of Danish Telephone Rates

Announcement has been made that effective October 1, Danish state telephone rates were lowered from 10 to 37 per cent.

Inaugurate Automatic Service

Automatic telephone service has been inaugurated in the railway town of Changchun, China, according to a radiogram from Assistant Trade Commissioner C. E. Christopherson, Mukden.

Damage estimated at $40,000 was caused by a fire in the Ashland exchange of the Wisconsin Telephone company. The fire, of undetermined origin, disrupted local and long distance service for several hours. Long distance trunk lines were repaired immediately and 90 per cent of the local lines were in working order within 48 hours after the fire.

Placing of Aerial Cables by Suspension

Importance of Placing Messenger at Proper Tension in Aerial Cable Construction Here Explained by Ray Blain, Who Says This Is Necessary to Prevent Bowing Which Results from Tight Messenger, and Explains Construction and Use of Tension Indicator

Most anyone familiar with telephone construction methods can follow standard specifications and build a pole line which will not develop trouble later due to faulty construction. The placing of aerial cable carried by a suspension strand on the poles to give like results presents a far more difficult problem. The average construction man prefers to see a cable hung on a tight messenger for he is of the opinion that it looks better, but this tight cable will usually develop trouble later due to bowing. This bowing is caused by the unequal expansion and contraction of lead and steel. The lead cable expands more than the strand on a temperature rise. When the temperature rises above the point at which it was spliced the cable expands faster than the messenger and as it can't very well move through the rings compression is set up within the cable itself. When this compression exceeds the bending resistance of the cable it naturally bows out of line. The amount of bowing will depend on the amount of temperature rise above that at which it was spliced. When the temperature drops the cable will contract faster than the messenger and when it gets below the splicing point tension is placed on the cable. If the cable is spliced in hot summer the tension developed during the first cold spell may stretch the cable considerably. When the temperature again rises the cable will be placed under compression quickly, and serious bowing will result as the cable has been permanently stretched.

The most logical means of preventing bowing in a new cable is to place the messenger at the proper tension at the time of its construction. While many formerly advocated placing a tension of 6,400 lbs. at 60 degrees Fahr. under the new practice it would be pulled to about 3,600 lbs. at this temperature. Decreasing the initial load on the messenger will permit an increase in the expansion and contraction of it with temperature changes. This results in a more equal length of messenger and cable at all temperatures and the danger of bowing is reduced to a minimum.

Tension Indicating Methods

There are three methods whereby it is possible to determine the amount of sag advisable to leave in a messenger at the time it is placed in service to properly take care of the expansion and contraction due to temperature changes. They are the sighting method, the oscillation method and the use of the shunt type tension indicator.

The sighting method is quite simple and consists of placing a sag gauge on each pole of the test span and sighting across the point on the gauge corresponding to the amount of sag desired. It is always best to pull the messenger higher than required and then slack off to the point desired.

When the oscillation method is used the messenger should be first pulled tighter than desired and then slacked off to what is estimated the tension desired. The span is made to oscillate by a lineman on a pole striking it hard and sudden with his hand about two feet from the pole. By oscillations is meant the complete cycle of motion of the messenger in returning to its starting point. When the oscillations are small the messenger should be made to oscillate sideways and when they are great it should be made to oscillate up and down. The man on the pole can hold his finger near the messenger and count the oscillations over a period of about fifteen seconds. This number can be checked with a table to determine whether the messenger has been pulled to the proper tension. If the number of oscillations are less than required, the messenger must be pulled tighter and if more than required it must be slacked off. A small hand line can be thrown over the center of the span of messenger if desired and the oscillations counted from the ground.

Both the sighting and the oscillation methods can be considered as makeshifts and are by no means accurate. The use of the tension indicator is a simple task and it removes all element of doubt. This instrument is clamped on the messenger being pulled, watched carefully until the required tension has been reached and then the messenger is deadended without fuss, worry or bother.

Constuction and Use of Tension Indicator

The shunt type tension indicator is an instrument which can be used to indicate the tension on any type of wire either solid or stranded. It operates on the deflection principle and can be placed on any portion of a line to indicate the load then on it; also any variation in the load.

The principle of this device is simple. A slight offset is made in the line between two fixed points. The pressure to make this offset is balanced by a fluid body behind a flexible diaphragm. This pressure is a direct measure of the load on the line. It becomes simply a force triangle with the line loads forming two sides and the pressure exerted by the fluid forming the other. This deflection is so slight that there is no danger of a permanent set or distortion of the messenger.

The instrument is small, neat, rugged, accurate and of light weight. Besides being ruggedly built it has no delicate adjustments, moving parts or springs of any kind which makes it positive and reliable. It is constructed to withstand the hard usage and treatment that it might be subjected to while in the hands of a construction gang. Incidentally any replacements made necessary by abuse can be made easily and quickly.

The readings can be quickly and easily made. In fact it takes less than a minute to clamp the tension indicator on the messenger, take the reading and remove it. This instrument is made in two sizes, the Standard and Heavy Duty types. Both embody the same fundamental mechanical principles.

The Standard tension indicator is made of high tensile aluminum alloy and weighs but 11½ pounds. Hardened steel contacts prevent wear where the line comes in contact with the instrument, insuring accuracy and the maintenance of a constant deflection. To increase the accuracy, the instrument is loaded with an anti-freeze fluid under a high vacuum so as to insure removal of all air. The standard fluid used will withstand a temperature of ten degrees below zero. All steel used on the instrument is heavily udylited to prevent rusting.

This small instrument will take lines from ¼ to ¾ in. in diameter and is furnished with one of three tested gauges for the following maximum capacities: A 30-pound gauge reading to approximately 3,500 pounds; a 60-pound gauge reading to approximately 7,500 pounds; and a 100-pound gauge reading to 16,000 pounds. The maximum capacity varies somewhat with the material, diameter and the make up of the strand.

A correction is provided for use in case of large temperature variations. The correction required is indicated and can be made easily by anyone in the field without the aid of special tools or equipment, and without any necessity of checking or calibration. The Standard tension

(*Continued on Page 27*)

Telephone News From the Southwest

Notes of Telephone and Utility Interests in the Central Southwest Which Previously Were Reported for Transmitter and Electrical Journal, a Regional Magazine of that District Which Has Been Absorbed by TELEPHONE ENGINEER, Appear in the Following Columns

Tidings From Texas

Busiest Season Is On

Harvesting of the cotton crop is in full swing and long distance telephone operators for the first time in many months are having to report: "The circuits are busy; I will have to call you."

Former Telephone Man Dies

Word has just reached friends in Texas that W. J. Stanton, well known telephone man and veteran of the Spanish-American and World Wars, died at his home in Hemstead, Long Island, in February. For many years Mr. Stanton was connected with the telephone business in Texas, first as representative of the Monarch Telephone Manufacturing company and afterwards as local manager of the Bonham Telephone company's exchange in the city of Bonham. He gave up his position there when the United States entered the World War and volunteered his services. Mr. Stanton saw active service on the battle front and received a number of wounds which hastened his death. He was a major in command at the close of the war, although he only held a captain's commission.

Abilene Fights for Lower Rates

The Southwestern Bell Telephone company and the City of Abilene are still at variance over the matter of telephone rates. In answer to a request for lower rates, the telephone company reduced the business rate from $7.00 to $6.50 and the residence rates from $3.25 to $3.00 on September 1st. Not satisfied with this reduction, the city officials sent out a questionnaire to the 10,400 patrons of the company and 2,579 of them expressed themselves as being in favor of a still lower rate.

The Greenville Convention

The Texas Independent Telephone association held the first of a series of district conventions in the Washington hotel at Greenville on September 25th and 26th.

Sam H. Shutt, general manager of the Northern Texas Telephone company, of Sherman, presided at the several sessions.

The convention on Friday afternoon was given over to a discussion of plant and commercial problems. The really essential part of the meeting, however, was centered around the traffic conference which was held on Friday, the second day of the convention. There were 134 telephone managers and employes in attendance.

Roi Cornish, manager of the Gulf States Telephone company at Commerce, delivered an address on the subject, "Your Duty to Yourself." He was followed by W. M. Hemphill of the Southwestern Bell Telephone company of Dallas, who gave a talk on "Selling Telephone Service." Mr. Hemphill stressed the fact that until recently telephone companies had not pushed the sale of their product, allowing other lines of business to secure the dollar that otherwise might have gone to the telephone company. This subject was discussed by several others, led by H. B. Whatley, of the Southwestern Bell Telephone company of Dallas.

"The Usefulness of the Telephone as Viewed by the Patrons" was the subject assigned Oscar Jones, district governor of the Lions Club, Greenville. Joe Bennett, of Dallas, equipment supervisor of Three States Telephone company, addressed the meeting on "Proper Maintenance of Inside Equipment."

"The New Toll Operating Practices" was ably presented by William Swan, veteran traffic man and connecting company toll supervisor at Dallas.

The discussion of this subject was led by Miss Etta Mooneyhan, chief operator of Southwestern Bell Telephone company, Dallas, followed by Mrs. Rosa Hensley, chief operator of Texas Long Distance Telephone company of McKinney, and Mrs. Linnie Blalack, chief operator, Greenville Telephone company, Greenville.

Observations From Oklahoma

Rebuild Telephone Lines

A crew of the Southwest Telephone company is rebuilding the telephone lines in Cement, Okla. Lines are being placed in cables and the cables will be laid in alleys wherever possible.

Certificate of Heroism

A Red Cross certificate for heroism has been awarded to Fred Farris, an employee of the Southwestern Bell Telephone company, for his prompt action in spreading the alarm of the tornado at Bethany, Okla., November 19, 1930; giving aid to the injured, and saving the life of a fellow worker. When the tornado struck, he was working with a gang near Bethany. Taking an emergency set Mr. Farris tapped the telephone line that led to Oklahoma City and spread the alarm.

Mr. Farris, who was foreman of the gang, was credited with saving the life of Herbert C. Seamon, a lineman, by summoning him from a building as the storm approached. The building was completely destroyed. The Red Cross certificate, awarded to Mr. Farris, carries the signature of President Hoover and is the only recognition given by the National Red Cross in connection with the storm.

First-Aid Contest

The telephone is playing a useful part in safety and first-aid work of the Empire companies, with headquarters in Bartlesville, Okla. Two teams, one at Barnsdall, Okla., and the other at Oil Hill, Kansas, recently worked the same five problems pertaining to first aid in a contest which started at eight o'clock one evening. After each problem the total number of discounts were telephoned to the control station at Bartlesville.

These results were then exchanged so that a "running score" was kept at each place. The lead shifted three times during the contest, keeping the teams and spectators on their toes. Both teams like the idea of a telephonic meet and more are being planned.

Construct Toll Line

A toll line from Muskogee to Panama through Stigler, Okla., is being constructed by the Southwestern Bell Telephone company. Four gangs have been at work for several weeks on this project.

More Subscribers; Lower Rates

W. W. Lees, manager of the Coweta-Porter Telephone company at Porter, Okla., has informed his subscribers that

if he can write a sufficient number of new contracts for new telephone installations in Porter, he will ask the Oklahoma Corporation commission for a reduction in rates there. If the necessary new subscribers are secured Mr. Lees will put in the following rates: Business telephones, $2.50 per month, present rate, $3.00; residence telephones, $1.50 per month; present rate, $2.00. In either case 25 cents additional is charged for desk sets.

Attack Legality of Statute

In demurring to a suit in which the State of Oklahoma seeks to collect $144,203.78, corporation license and charter fees, alleged to be unpaid, the Southwestern Bell Telephone company attacked the legality of the statute under which the suit was brought. The suit was instigated by Governor William H. Murray as a part of his campaign to force reduction of utility rates in Oklahoma. The statute is revenue producing and therefore improperly passed; it discriminates against foreign corporations, and violates the interstate commerce regulations, the company alleges in its demurrer.

New Exchange at Wetumka

The new telephone exchange of the Southwest Telephone company at Wetumka, Okla., was cut over September 2. The old magneto system there was replaced by a common battery system. Work was begun in September, 1930. With the new exchange the company now occupies larger quarters and the offices have been refurnished.

Modern Board at Crescent

A modern telephone board has been installed at Crescent Okla., by the Western Telephone corporation. The new board has an increased capacity for accommodating local and rural subscribers.

Promise Improvements to Beaver

The Southwestern Associated Telephone company has announced that it will add improvements to its exchange at Beaver, Okla.

Complete Long Distance Cable

Construction work on the new long distance underground telephone cable, connecting Joplin, Mo., with Tulsa, Okla., will be completed and the line placed in service next March, according to H. H. Armstrong, division superintendent of the Southwestern Bell Telephone company in Tulsa. For the last two months work crews have been placing cable southwest of Joplin to Tulsa. A new building to house telephone repeaters or amplifiers is being erected 2½ miles southwest of Vinita. Repeater stations located about fifty miles apart on the underground toll cable system of the company will be used to boost the weakened voice currents.

Downs Sells Private Lines

H. W. Downs has sold and delivered his privately owned telephone lines in Harper county, Okla., to the Southwestern Associated Telephone company, owners of several exchanges in Oklahoma. The amount of consideration has not been announced. Mr. Downs established the first telephone exchange in Buffalo, Okla., 24 years ago and has been actively engaged in the telephone business ever since. The property now sold includes twelve rural lines out of Buffalo and one out of Selman. The Southwestern Associated Telephone company owns the local exchanges in these towns.

Two White Spots on Map

Durant and Bethany are two of the white spots on the business map of Oklahoma, according to Joe Page, of Durant, district manager of the Southwestern Bell Telephone company.

From January 1 to September 1 of this year Durant showed a gain of twelve telephones and Bethany, which was partially destroyed by a tornado last year, showed a gain of thirty telephones.

District Telephone Meetings Held

District meetings of the Telephone Division, Oklahoma Utilities association, were held at Wetumka September 22, and at Welch September 24. Attendance including guests was 57 at Wetumka and 46 at Welch. The Wetumka meeting was held under auspices of the Southwest Telephone company. Speakers included R. A. Holmes, Okmulgee, district plant chief; C. A. Smith, Tulsa, commercial supervisor; B. H. McConnell, Okmulgee, district manager, all of Southwestern Bell Telephone company, and C. G. Gardner, sales representative, Kellogg Switchboard & Supply company and chairman telephone division.

The Welch meeting was held under auspices of the Welch Bluejacket Telephone company, with C. G. Gardner presiding. E. E. Noe, Welch, manager, Welch-Bluejacket Telephone company, acted as secretary. Among those who addressed the business session of the Welch meeting were: S. A. Knapp, Miami, district plant chief, Southwestern Bell Telephone company; E. F. McKay, Oklahoma City, manager, Oklahoma Utilities association; Mr. Gardner, and C. J. Noe, Welch, assistant manager, Welch-Bluejacket Telephone company.

General discussions at the meetings included rural line telephone service, public relations, commercial and traffic practices, accounting, construction methods, local and long distance service, maintenance of plant, and other important subjects.

PLACING OF AERIAL CABLE

(*Continued from Page 25*)

indicator is the one which will meet all telephone construction requirements.

Telephone Applications of Tension Indicator

Besides performing that all important task of determining the proper strain to put on an aerial cable messenger, the tension indicator can be used to advantage to determine the strain on cable which is being pulled into underground conduit. This avoids placing enough strain on a cable to ruin it which often happens when pulling blind.

When a number of down guys hold a heavy corner the tension indicator can be used to determine whether each guy carries its share of the load and is very useful in equalizing them.

This instrument is also useful in preventing the overloading of guys and anchors. The above are only a few of the many applications of the tension indicator in the telephone exchange. The tension indicator will find a place on every construction job and the avoiding of one mistake may save its cost many times over. This instrument should be investigated by every wideawake manager and construction superintendent.

NEW CENTRAL OFFICE FOR CITIZEN'S MUTUAL

The final cut-over of the Citizens' Mutual Telephone company took place recently, and all telephones in Bloomfield, Ia., and rural lines, are now working out of the new central office located in Bloomfield.

The company occupied the same quarters in Bloomfield since 1904, until the recent growth of the exchange made new offices imperative.

Bloomfield now has a fine two-story brick building, fitted with the best of equipment, and constructed at an outlay of $14,500. The present system furnishes service to 650 homes in Bloomfield and to 375 rural homes. On the average, Bloomfield has a phone for about every third person.

The switchboard permits the addition of 500 drops if time makes it necessary for a greater number. Nine regular girls and three extra ones are required to furnish the service.

WE HAVE MOVED

Editorial and advertising offices of TELEPHONE ENGINEER, for the last several years located at 192 N. Clark St., Chicago, have been moved to larger and more centrally located quarters, at 185 N. Wabash Ave., Chicago. The telephone remains the same, State 8971.

"B" Trunk Calls to Trouble Operator

Methods of Signaling Operators as Well as Subscribers of Lines and Trunks Out of Order Here Described by John H. Levis, Jr., Telephone Engineer, Rochester, N. Y., in the Fifteenth Installment of His Articles on the Straightforward Trunking System

In every large central office there is a certain percentage of lines or outgoing trunks that have some sort of trouble and to properly indicate to both the "A" and "B" operators who make connections to these circuits that the circuits are in trouble, an out-of-order or trouble cord is used.

The out-of-order or trouble cord places an out-of-order tone on the sleeves of all the multiple jacks of the line or outgoing trunk in trouble. This tone is of a low frequency of about 133 cycles.

Either the "A" or "B" operators receive the low tone when making the usual busy test on the multiple of a line or trunk in trouble.

The usual busy test is a click in the receiver indicating that the line or trunk is busy and is reported verbally as such by the "A" operator to the calling station. The "B" operator uses the well known busy back tone which has been described in a previous issue of TELEPHONE ENGINEER. When the "A" operator tests a called for line and obtains both a click and the low tone it indicates that the line called for is out of order and the operator verbally reports to the calling station that the line is out of order.

When, in operating a straight forward trunk with pre-select ringing, the "B" operator encounters the low out-of-order tone when testing a line called for, she does not report the line out of order verbally to the calling distant office station because when pre-select is used the "B" operator is not connected to the trunk and, therefore, cannot report back the condition of the line. The pre-select feature has been described in a previous issue of TELEPHONE ENGINEER.

In order to convey the trouble condition of the line called for to the calling station, the "B" operator places the trunk plug with which the test was made into an idle or non-busy outgoing trunk to the trouble operator who has the information pertaining to the lines or trunks that are out of order.

The out-of-order or trouble trunks are multiplied before all "B" operators.

The incoming end of the out-of-order trunks are generally placed before the "A" operator of the initial position of the "A" switchboard and are equipped with incoming lamp signals and are designated as trouble trunks by lamp cap designation. Regular answering lamp and jack equipment is used.

The out-of-order or trouble cords are generally located in the annex position of the "B" switchboard, that is, the cords used for regular lines. The out-of-order cords used for outgoing trunks are placed in the annex position of the "A" switchboard because 98 per cent of the outgoing trunks are in the "A" switchboard. The "A" and "B" switchboard out-of-order cords are identical in circuit design and tone.

Before an out-of-order cord is placed into a line some one of the operating department is designated to determine, by means of line testing equipment, the condition causing the trouble. Many times the permanent line signal trouble is caused by a receiver left off of the hook and, in this case, the graduated Howler is placed on the line which is used to attract the subscriber to the telephone by causing the receiver to "howl." If the station cannot be raised by the Howler the trouble cord is placed in the line jack. The same is done when the line is grounded and causing the permanent signal.

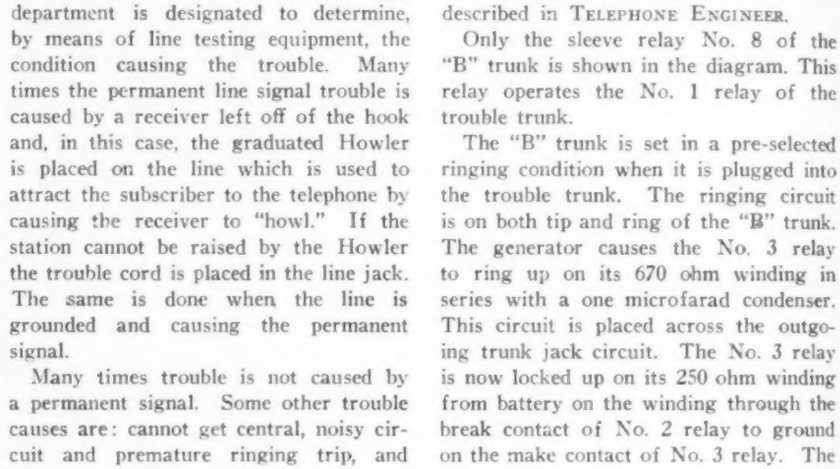
Many times trouble is not caused by a permanent signal. Some other trouble causes are: cannot get central, noisy circuit and premature ringing trip, and many other causes. These conditions generally are reported to the telephone company by the subscriber and are investigated by the wire chief of the exchange involved. He makes tests from the test desk and then issues orders that the line in trouble be plugged up with an out-of-order cord and it remains so until the line in trouble is placed in operating condition. In some cases the trouble on lines is located in the central office line wiring or equipment.

The circuit diagram shows mainly the trunk to the trouble operator which is located in the "A" switchboard. It is assumed that the reader understands the operation of the incoming signal and ringing circuits of the incoming "B" straightforward trunk circuit as all of the functions of the trunk have been described in TELEPHONE ENGINEER.

Only the sleeve relay No. 8 of the "B" trunk is shown in the diagram. This relay operates the No. 1 relay of the trouble trunk.

The "B" trunk is set in a pre-selected ringing condition when it is plugged into the trouble trunk. The ringing circuit is on both tip and ring of the "B" trunk. The generator causes the No. 3 relay to ring up on its 670 ohm winding in series with a one microfarad condenser. This circuit is placed across the outgoing trunk jack circuit. The No. 3 relay is now locked up on its 250 ohm winding from battery on the winding through the break contact of No. 2 relay to ground on the make contact of No. 3 relay. The ground on the relay No. 3 also lights the incoming signal at the answering jack before the "A" operator trouble position.

The operation of the No. 3 relay also causes the ringing of the "B" straightforward trunk to be tripped. This is



Circuit diagram showing "B" Straightforward trunk to trouble operator through trouble trunk circuit and trouble operator's cord circuit.

caused by the ground on the No. 3 relay being placed on the 2,000-ohm non-inductive coil and through it to the ring side of the trunk. This is the side of the "B" trunk to which the trip relay is connected and it terminates with 40 volts negative battery.

On plugging in, the "B" trunk ringing is tripped immediately, so that the "A" operator will not get a possible ring in the ear upon answering the call.

The No. 3 relay also places the regular office audible ringing circuit on the "B" trunk through a one-microfarad condenser. As the "B" trunk ringing control relay is tripped, which causes the audible signal of the "B" trunk to be removed from the circuit, it is necessary to replace the audible signal for the calling station as it has called for a line number and it should receive the audible ringing signal until the call is answered. In this case an operator answers to inform the calling station that the line called for is out of order. The trouble operator answering with the back cord of a cord circuit causes the No. 2 relay of the trouble trunk to operate from the No. 1 relay of the cord circuit. The operation of the No. 2 relay opens up the lock-up circuit of the 250-ohm winding of No. 3 relay allowing No. 3 to release. This causes the incoming signal lamp to be extinguished and the audible ringing signal and the ringing trip circuit of 2,000 ohms to be removed. The No. 2 relay operation again places the 2,000 ohms on the ring of the circuit for tripping. This is done so that the "B" ringing would be tripped if the trunk should be taken again before the "A" trouble operator has removed the back cord from the answering jack.

The 2,000 ohm tripping circuit will not operate the battery supply relay No. 2 of the "B" trunk circuit, allowing the bridge back circuit of relay No. 1 to function. This is done so that the distant office front cord supervisory relay equipment will not operate. As automatic line message meter and automatic coin collecting circuits are used in regular "A" and pay station cord circuits, it is obvious that a calling station should not be charged for line out of order reports.

The No. 1 relay of the trouble trunk closes the circuit of the No. 4 impedance coil across the answering jack side of the trunk. It is in the circuit so that supervision can be obtained in the trouble operator's cord circuit. The No. 2 relay in the cord circuit is the supervisory lamp control relay and it operates immediately on plugging into the trouble trunk when it is taken by a "B" trunk plug. In this case the supervisory lamp is extinguished.

The trouble operator talks to the distant office station by means of the listening key in the cord circuit.

When the information is given to the calling station by the trouble operator it hangs up, causing the back cord lamp of the distant office cord circuit to light. It also lights the front cord lamp in case of an "A" cord circuit dark or semi-dark keyshelf. This indicates full disconnect to the distant "A" office operator and the front and back cords are removed from the jacks. The disconnect from the outgoing trunk jack causes the disconnect lamp signal of the "B" straightforward trunk to light and the "B" operator removes the trunk plug from the outgoing trouble trunk. This causes the No. 1 relay of 500 ohms to release, opening up the circuit of the 500 ohm No. 4 impedance coil which held the No. 2 relay of the cord circuit operated. The No. 2 relay releases and the back cord supervisory lamp lights from its circuit which is closed at No. 1 and No. 2 relays. The transmission circuit of the trouble trunk is of the series condenser type.

It is well to mention that there are times the trouble operator is unable to convince the calling station that the line called for is out of order and in this case the complaint is passed on to the chief operator or manager. The "A" operator then places the front cord of the cord circuit into the proper jack circuit, setting the cord circuit as required, that is, ringing or non-ringing.

C. D. KINNE NEW GENERAL SALES ENGINEER FOR STROMBERG-CARLSON

Promotion of C. D. Kinne, assistant manager of the Kansas City branch of Stromberg-Carlson Telephone Manufacturing company, to general sales engineer, is announced by that company through George A. Scoville, vice president and sales manager.

C. D. Kinne, newly appointed General Sales Engineer of the Stromberg-Carlson Telo. Mfg. Co.

In making the appointment, Mr. Scoville said:

"In recognition of Mr. Kinne's ability and the splendid work he has done as assistant manager of our Kansas City branch, we are appointing him general sales engineer. By doing this, Stromberg-Carlson is giving telephone managers and owners an opportunity to benefit from the experience and knowledge of one of the best telephone men in the country.

In 1900, when Independent telephony was just beginning to find its place in the industry, Mr. Kinne accepted a position as ground man with the American Telephone & Telegraph company.

In a short time he had served his apprenticeship, graduating to the class of lineman. For three years he worked as lineman for the American Telephone & Telegraph company, the telegraph department of the Erie Railroad company and the Hudson River Telephone company. The year spent with the Erie Railroad company is the only time since 1900 that Mr. Kinne has not been directly connected with either a telephone operating or manufacturing company.

In 1904, the Utica Home Telephone company of Utica, N. Y., secured his services as inspector. But after a year the Herkimer County Telephone company of Herkimer, N. Y., offered him a greater opportunity in the capacity of superintendent.

He returned to Utica in 1907 as plant superintendent, where he remained for five years, which were followed by eight years with the New York Telephone company, where he was district supervisor of maintenance.

It was not, however, until 1920 that Mr. Kinne found the work in which he was to excel. Going to the Stromberg-Carlson Telephone Manufacturing company as a practical operating telephone man, he was given the entire state of Texas in which to distribute Stromberg-Carlson products.

By the fall of 1926 he was relieved of the responsibility of selling throughout the state and was called into the Kansas City offices as a sales engineer.

In this capacity he was able to keep in touch with his old friends and also do much constructive work in handling their central office requirements.

In 1928 the Stromberg-Carlson company made Mr. Kinne assistant manager of the Kansas City branch. In this position he continued to serve the telephone companies of Texas and his influence has been felt throughout the entire territory served from Kansas City.

His new position will allow him to continue his outstanding work in the Kansas City territory and in addition he will be able to serve companies in other sections of the country.

Characteristics of Strowger Relays*

Discussion of Characteristics of Various Special Types of Relays Together with Explanations of Accompanying Graphs Which Show Details of Their Operation

By K. W. GRAYBILL
Research and Development Department, Automatic Electric, Inc.

The four preceding articles of this series have discussed in a general way the fundamental features of design which are of importance in any relay structure, and have discussed in detail the laboratory methods used in analyzing the characteristics of a particular type of relay and the interpretation of the data obtained from these analytical tests. Since the laboratory methods used and the data taken are similar for all types of relays, the following discussions of the characteristics of special types of relays are presented without a detailed explanation of the included data.

The introduction of vacuum tubes and particularly of photo-electric cells into many industrial uses has made it desirable to operate relays on a current of .0005 amperes or less. The usual standards of engineering do not permit the use of the low spring pressure and low factor of safety necessary to provide operation of the horizontal type or similar

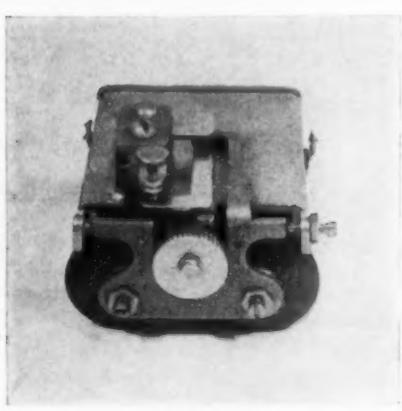


Figure 1

types of relays on such small current values. For such service the twin coil type of relay illustrated in figure 1 and figure 2 performs very well. Figure 2 shows the relay mounted under a glass cover with connecting terminals on a base outside the cover. This type of relay employs two coils, thus providing a large winding space and distributing the winding so as to provide a very efficient magnetic circuit. The armature is suspended on pivots which permit practically fractionless operation. Both the armature stroke and the spring tension are adjustable by means of thumb screws which permit easy and very accurate adjustment.

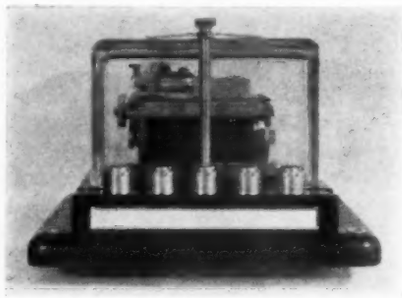


Figure 2

The sensitivity of this type of relay is disclosed by the pull curves in figure 3. Comparison of the twin coil relay and the horizontal type of relay with regard to sensitivity may be made by referring to the pull curves in figure 4. Curve No. 1 in figure 4 records the pull of a twin coil relay for an armature stroke of .015 while curve No. 2 in the same figure records the pull of a horizontal type for the same armature stroke. It will be observed that the ordinate values for this curve are recorded in centimeter-gram values instead of in grams as used for similar data in article No. 3 of this series.

This practice is necessary to permit direct comparison of the pull of two relay structures having different armature lever ratios. The centimetergram values are true values of work since they are the product of the weight lifted and the distance through which this weight is lifted. The centimetergram pull curve for a given armature stroke remains the same for a given type of relay regardless of the armature lever ratio used, as a change in the point of applying the load results in such a change in the load that the product of the two remains the same. A twin coil relay wound to 14,000 ohms total resistance with No. 40 B. & S. gauge wire will operate a single break contact springs assembly adjusted to 15 grams normal contact pressure and to provide .008" contact separation with .0004 amperes. A further reduction in operating current can be obtained if conditions permit the use of a smaller contact opening and a lower spring pressure.

A modification of the horizontal type relay structure is illustrated in figure 5. This relay is called the three pole electro-polar relay and has characteristics quite different from those of an ordinary electro-polar relay. An electro-polar relay usually has two windings one of which is called the polar winding while the other is called the operating winding. Circuit conditions usually require that an electro-polar relay shall not operate with the polar winding alone energized or with both windings energized to produce opposite magnetic polarities but shall operate with both windings energized to produce the same magnetic polarity.

The three pole electro-polar relay has two windings between which is located a specially shaped iron washer. An iron

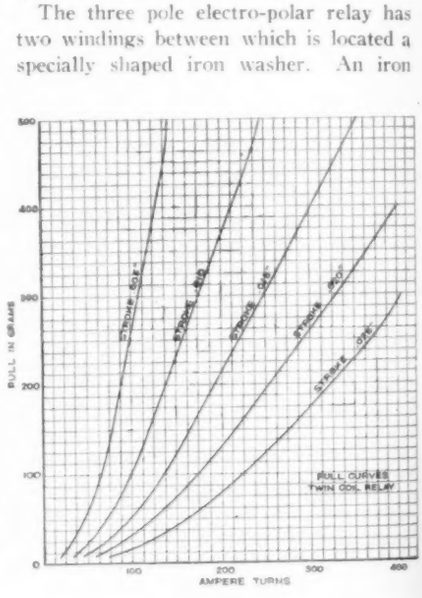


Figure 3

member attaches to this washer and serves as the armature back stop. The position of this back stop is adjustable to permit variation of the relay stroke. When the polar (terminal end) winding alone is energized the flux divides forming one path through the core and across the air gap to the armature and another path through the armature back stop and armature. With a properly designed polar winding the flux through the armature back stop is sufficient to hold the armature in its non-operated position.

*Editor's Note: This is the first half of article 5 of a series by Mr. Graybill dealing with relay characteristics. The second half will appear in the next issue.

With a properly designed armature end winding energized opposing the polar winding sufficient flux continues to find a path through the back stop and armature

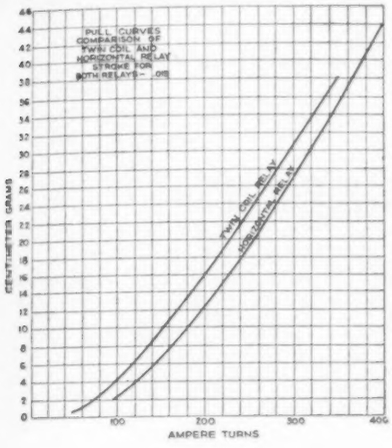


Figure 4

to hold the armature at normal.

With both windings energized to produce the same magnetic polarity the flux across the air gap between the core and armature is greatly increased, thus causing operation of the armature.

The operating characteristics of this type of relay are recorded by means of pull curves in figure 6. Each curve in figure 6 corresponds to a certain armature load (10, 25, 50, 100, 200 and 300 grams). The abscissa values represent ampere turns produced by current through the polar winding with only one polarity considered. The positive ordinate values (above the zero line) represent ampere turns in the operating winding of the same magnetic polarity as that of the polar winding. The negative ordinate values (below the zero line) represent ampere turns in the operating winding of

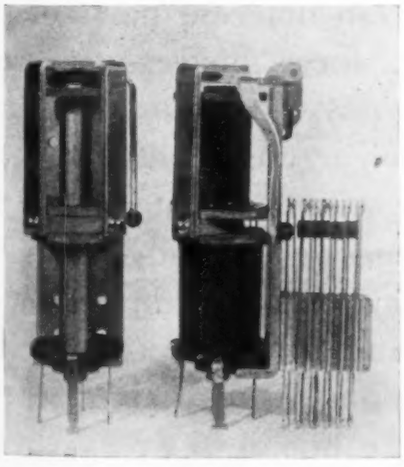


Figure 5

an opposite polarity from that of the polar winding.

The "A" group of curves records the ampere turns required simultaneously in both windings (aiding in polarity) to operate the various loads.

The "B" group of curves records the ampere turns required simultaneously in both windings (opposing in polarity) to cause release of the armature after it has been operated with the windings aiding ("A" condition).

The "D" group of curves records the ampere turns required simultaneously in both windings (opposing in polarity) to cause operation of the armature as the result of excess ampere turns in the operating winding. This group of curves is useful in guiding the design of operating windings so they will not be made too powerful.

The "C" group of curves records the ampere turns required simultaneously in both windings (opposing in polarity) to cause release of the armature after it has been operated by an excess amount of ampere turns in the operating winding under the condition (opposing polarity) represented by "D" group of curves.

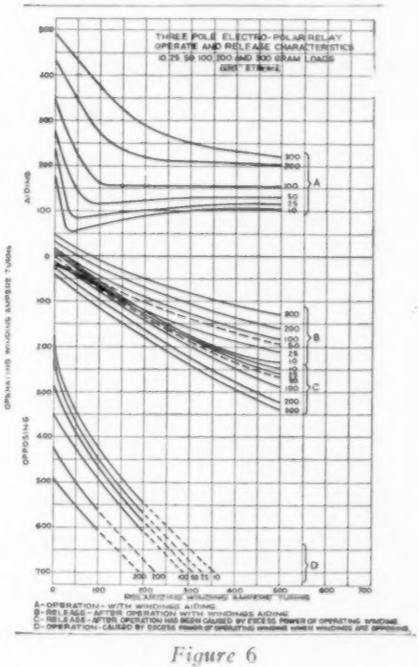

THREE POLE ELECTRO-POLAR RELAY
OPERATE AND RELEASE CHARACTERISTICS
10,25 50 100,200 AND 300 GRAM LOADS
AIDING
OPPOSING
OPERATING WINDING AMPERE TURNS
POLAR WINDING AMPERE TURNS
A
B
C
D
A- OPERATION - WITH WINDINGS AIDING
B- RELEASE - AFTER OPERATION WITH WINDINGS AIDING
C- RELEASE - AFTER OPERATION HAS BEEN CAUSED BY EXCESS POWER OF OPERATING WINDING
D- OPERATION - CAUSED BY EXCESS POWER OF OPERATING WINDING WHEN WINDINGS ARE OPPOSING

Figure 6

The three pole electro-polar relay is superior to the ordinary electro-polar in the following characteristics: The polar winding may be designed to have a large number of ampere turns without danger of causing operation when this winding is energized alone. This large number of ampere turns in the polar winding aids in operating large spring loads and in providing very quick operation after reversal of the line winding because the polar flux is made useful in securing operation by the energization of the operating winding with aiding polarity. Increase in ampere turns of the polar winding up to the maximum permissible values does not demand a like increase in ampere turns of the line winding to prevent operation with the windings opposing. A comparatively large number of ampere turns may be developed by the line winding when it opposes the polar winding without causing false operation (limited by curves "D").

ILLINOIS STATE CONVENTION NEXT MONTH

The twenty-seventh annual convention of the Illinois Telephone association will be held November 18 and 19 at the Pere Marquette Hotel, Peoria. The third floor space of the hotel has been set aside for exhibition purposes.

POSSIBILITIES OF A. T. & T. CONTINUING DIVIDEND

The ability of the American Telephone & Telegraph company to pay out approximately $168,000,000 in dividends next year, at the current rate of $9 a share, it is believed depends to a large degree on the manner in which the associated companies of the Bell System are able to continue to show increased net earnings despite declining gross revenues.

This year, it is estimated, dividends of about $163,500,000 will be earned by a margin which may be $4,000,000 or more.

The parent company of the Bell System, it is stated, has never drawn to the fullest extent possible on the surplus earnings of the associated companies.

NEW DENVER EXCHANGE NEARS COMPLETION

The new $96,000 South exchange building of the Mountain States Telephone & Telegraph company, in Denver, is expected to be completed soon, it has been announced.

Erection of the building marks the first step in a $1,800,000 program to transform south Denver telephone service to the dial system.

As soon as the new building is finished, engineers and workmen will start installing automatic switchboards and other equipment, and laying underground cable.

When all equipment is ready, the phones will be cut over to automatic operation late in the spring of 1932, according to Dean D. Clark, Denver commercial manager of the telephone company.

NEW PLANT FOR PORT ARANSAS

Announcement was made recently that The Texas Telephone company contemplates the installation of a new common battery telephone exchange at Port Aransas, work to be started at an early date. The exchange will be housed in a new building and the entire outside plant will be rebuilt and enlarged so as to accommodate a constantly growing demand for service.

Advocating TELEPHONE

to the ARCHITECT before the house is built

IT IS easy and most economical to provide for home telephone convenience in the architect's original plan—before the builder has begun construction. At that time floor plans may be studied and locations selected so as to insure convenient and flexible service for present and future needs.

For that reason, telephone convenience is being recommended to architects by advertisements like the one on the opposite page. Appearing in architectural publications, this advertising stresses the time and energy saved by properly placed telephones—the distinctive, livable atmosphere that is created—the owner-satisfaction that results. It emphasizes also the importance of conduit built into walls and floors to conceal all wiring and protect against service interruptions. Always, it offers the full and free co-operation of the local telephone company.

Illustrations show attractive homes of all kinds—from houses with five or six telephone outlets to large estates having half a hundred or more. Floor plans and conduit layouts are included. Selected from different parts of the country, these houses represent many types of architecture and telephone arrangements.

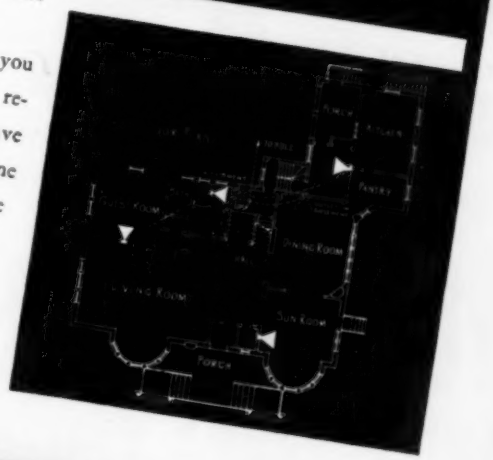
There are many instances of the effectiveness of this advertising in its special field. It is implanting an idea—and advocating specific facilities that serve to stimulate the telephone business everywhere.

An Advertisement of the American Telephone and Telegraph Co

Convenience

Built-in conduit and ten telephone outlets provide for convenience in the residence of Mr. Eben Atwood, Lake Minnetonka, Wayzata, Minnesota. A. R. Van Dyck and Floyd W. Brown, Architects.

TELEPHONE CONVENIENCE MAKES MODERN HOMES MORE LIVABLE



Telephone convenience is saving steps and minutes in modern homes throughout the country—in distinctive, livable homes like the one illustrated, which overlooks beautiful Lake Minnetonka.

Telephone convenience is simply the placing of telephones at the handiest locations in the most important rooms. It is easily and economically achieved by planning in advance—by providing built-in conduit and outlets in walls and floors. The conduit conceals all wiring, permits the placing of telephone outlets wherever they're wanted and protects against most types of service interruptions.

Let the local telephone company help you with the telephone arrangements for new or remodeled residences. Such consultation will save you time and trouble and assure lasting telephone satisfaction to your clients. There is no charge. Just call the Business Office.

Coordination and Subordination of Service

This Is the First Article of a Series on "A Development Study of the Toll Center District," Prepared Exclusively for TELEPHONE ENGINEER by F. J. Dommerque, Fellow A. I. E. E., Wherein the Orientation of the Universal Telephone System of the United States Is Presented

Introductory Remarks

The world is entering the era of coordination and subordination of mechanical and electrical communication. The automobile has increased the speed of locomotion on the highways. The locomotive is increasing its speed on the rails. The airplane and airship have left behind in speed the automobile and locomotive. Also on the ocean speed records are being established by the Europa and Bremen. However, each form of locomotion has pursued its own course independently of the others to attain the high degree of speed. The real usefulness to the world at large of this speeding-up process will then be achieved when all the methods of propulsion are coordinated and subordinated. This combination process is now taking place.

We see the same trend in electrical communication. In each community of the country the local telephone service has been speeded up to such an extent that we have practically annihilated the waiting of a subscriber for a response from the operator. The A-B method of handling calls to and from the area around cities and towns nearly equals in speed the local service. By discarding the recording operator and combining his position with the toll position the time of putting up long distance connections has been considerably abbreviated. We are now at the stage where the three services are being co-ordinated and subordinated to effect a country-wide service of maximum speed at minimum cost.

The end in view is the establishment of a universal telephone system which gives satisfactory communication between any two points in the United States at first, and later over the globe regardless of distance.

Telephone transmission is limited by the condition of the line. The subscriber talking into the microphone generates a certain amount of energy, which is transmitted over the line; this energy on its way is attenuated in proportion to the length of line, resistance and other line constants; and enough of it must arrive at the other end to operate the receiver diaphragm. The amount of attenuation permissible in the line is therefore the difference between the energy created by the talker and the energy required to operate the receiver. The lower the resistance of a line, the longer will be the distance over which transmission can be effected. Whenever the energy will not reach the receiving end in sufficient quantity to operate the receiver it may be increased by the insertion of repeaters in the line, and thus theoretically a transmission line may be produced which is indefinitely long and still permits of operation of the receiver; but practically economical reasons demand that there is set a maximum permissible transmission loss between any two telephones. With this in mind the American Telephone and Telegraph Company has arranged its toll and long distance system so as to answer not only the requirements of satisfactory transmission, but also in such a way as to remain inside the requirements of economy. It is of the greatest importance

Fig. 1—Map showing location of points tentatively selected as regional centers and primary outlets in United States and Canada.

GOOD SERVICE

TO TELEPHONE COMPANIES HAS BUILT OUR BUSINESS OF SELLING

TELEPHONE DIRECTORY ADVERTISING

Business established in 1910 with one Telephone Directory.

■

Better results can be obtained by an organization which is engaged exclusively in telephone directory work.

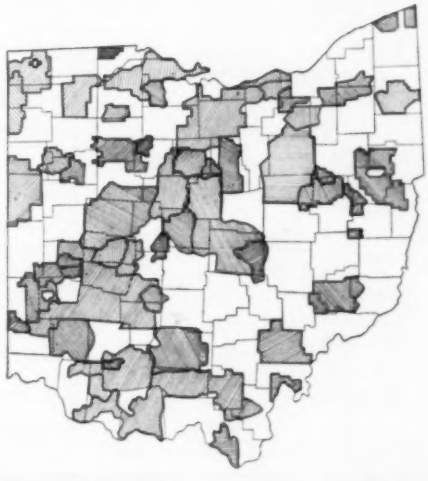
References: Any Telephone Company whose work we do.

■

Building up and maintaining good public relations is a part of our service to Telephone Companies.

DIRECTORIES FOR WHICH WE NOW SELL THE ADVERTISING COVER OVER 2,500 CITIES AND TOWNS IN THE TWENTY-ONE STATES SHOWN IN THE SHADED PORTIONS OF THE ABOVE MAP

In our home state of Ohio -- where our business was established twenty-one years ago -- we are now selling all of the Directory advertising for the Telephone Companies shown in the shaded areas of the map on the right.



104 Telephone Directories for which we sell the advertising in Ohio reach 314 cities and towns.

■

Telephone, wire or write for our proposition.

L. M. BERRY & COMPANY

TELEPHONE DIRECTORY ADVERTISING EXCLUSIVELY

MAIN OFFICE: Telephone Building
DAYTON, OHIO

that all operating companies participating in the benefit of this toll and long distance system co-ordinate and subordinate their wireplant and exchanges with the Bell toll system in order to reach the highly desirable goal of universal telephone communication.

As the toll center is part and parcel of this universal system it will be opportune to familiarize ourselves first with the Bell toll system.

General Plan for Bell System Toll Service

At the summer convention of the American Institute of Electrical Engineers in 1930, H. S. Osborne, the transmission engineer of the American Telephone and Telegraph Company, presented a general switching plan for telephone toll service, which has been developed to be followed during the near future. The fundamental idea of this study is to limit the number of switches required for providing a connection between any two telephones to a few, and still give a service, which is economical to perform, rapid and reliable. However, this side of the plan is for the present not of primary interest for our development study, but still remains of importance as it limits the energy losses permissible in the toll center district, or, as Mr. Osborne terms it, the toll terminal loss. We will briefly review the most important points in the plan as far as they are connected with our study.

Fig. 1 is a reproduction of the map given by Mr. Osborne showing the location of "Regional Centers" and "Primary Outlets" in the United States and Canada. It may be stated that only the eastern part of Canada has been drawn into this toll plan on account of its close relation to the eastern part of the United States geographically as well as commercially. This is of no importance in our problem. From this map we learn first that the entire country is divided into eight "regions" telephonically, which have as "Regional Centers," that is, as principal switching points, the following cities: New York, Chicago, St. Louis, Atlanta, Dallas, Denver, San Francisco and Los Angeles.

These regional centers are interconnected by *direct* toll circuits. The regional centers are designated on the map by heavy black dots. All other places on the map are designated by light black dots. The latter places are the "Primary Outlets," which are such switching offices as have one or more *direct* toll circuits to one or more regional centers. There are also "Secondary Outlets," which are not specified on the map, as they are only supplementary offices. They also have direct circuits to one or more regional centers, but are intended to furnish alternate routes for reaching same. They are of no especial interest to us, nor are the "Secondary Switching Points," which are switching points intended to provide routs, which are more direct, thus reducing back haul for intra-area business.

Of primary outlets there are approximately 150, to which are connected in round numbers as many as 2,500 toll centers. This number includes the toll centers in eastern Canada, which, however, is immaterial. The map, of course, does not show these toll centers. The arc of the greatest importance to our study as they constitute the central points of the districts presenting the subject of our development study.

The arrangement of the exchanges tributary to each one of the toll centers is of such a variety that it would be impossible to illustrate it in any other way than by a typical example. This is done in Fig. 2, where two regional centers are

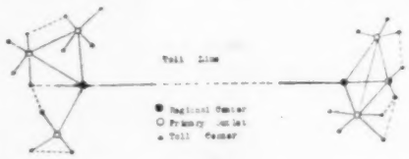


Fig. 2—Illustration of interconnection of switching offices in the Bell Toll System.

shown directly connected to each other and also each one connected directly to three primary outlets. Each one of the primary outlets is again shown directly connected to a few toll centers. In many cases there will be a greater number of toll centers tributary to each primary outlet, but the diagram presents a sufficient number for illustration. In Fig. 2 primary outlets are shown by small circles and the toll centers by small dots. The dotted lines indicate a direct connection between two toll centers, where the amount of business warrants additional circuits.

Toll Terminal Loss

We now present one of the most important requirements of the new plan for the universal system, namely the amount of attenuation loss, or, what amounts to the same, the transmission equivalent between the toll line end and the subscriber. The minimum working net toll terminal loss is specified as 7 db (decibel). For those accustomed to think in the old-time standard cable mile transmission unit it may be mentioned that there is not much difference between the standard cable mile and the decibel. One decibel equals 0.94 standard cable miles, whence 7 dc equals 6.58 standard cable miles. This provision has to be taken in consideration in any development study; it is, however, permissible on a direct toll circuit, that is, where no intermediate switching occurs from toll center to toll center, to figure on a working net loss of 9 db.

The transmission equivalent of a toll connection from calling to called subscriber is at a maximum equal to 31 db, of which 17 db are given over to the toll circuit proper, leaving 14 db to be divided between the two end terminals, or 7 db for each end terminal.

These 7 db have to be divided or rather distributed over the parts which form the end terminal, namely, the subscriber's line, the local switchboard, the toll switching or tributary trunk line and the toll position at the one end of the toll line.

Subscribers' lines vary in length and size of conductors. Giving to a subscriber's line a transmission equivalent of 4db should be a sufficient amount; it may bring the toll terminal loss for the longest toll connection over 31 db, but the toll calls originating in small exchanges inside the toll center district are mostly short-haul calls, and therefore the 17 db allowed for the entire toll circuit are rarely used to the full extent.

The toll switching trunk lines are of various length in a toll center district. It may, however, be assumed that most of them are comparatively short. Wherever they are too long to remain inside the limit we are about to set, they will have to be loaded; repeaters will hardly ever be required under ordinary circumstances. A limit of 2.5 db for the toll switching trunk should prove abundant.

It remains to fix an equivalent for the local switching position and for the toll position with their affiliated wiring. The local exchange should not require more than 0.8 db and the tollboard more than 1.2 db. We thus have an extreme equivalent of $4 + 2.5 + 0.8 + 1.2 = 8.5$ db. which actually exceeds the 7 db set by Mr. Osborne, but remains inside the limit of 9 db for direct toll connections. If a reduction is considered necessary, it may be made in proportion.

The above distribution of terminal loss is only tentative. It is particularly difficult to give proper rules for the transmission losses permissible in rural exchanges with their appendix of farmer lines. There we find a considerable amount of iron wire. Iron wire in itself is a poor sort of line material on account of its easy corrosion, whereby its adaptability for transmission is greatly affected, besides its other electric qualifications suffer as iron wire lines are frequently of inferior construction.

It is not opportune to go into this at the present time; the subject will be taken up again when we come to the discussion of line requirements.

MORE TELEPHONES

More than 540 new telephones have been added by Ohio companies of the Associated Telephone Utilities system since the first of September, according to an announcement by the company.

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Largest Co-operative Telephone Company Celebrates Anniversary

R. C. Reno of the Stromberg-Carlson Manufacturing Company, Rochester, N. Y., Writes of the Recent Gathering in Minnesota to Celebrate the Twenty-fifth Year of Activity for the Garden Valley Telephone Company

Recently the Garden Valley Telephone company held its 25-year celebration at Buhn's Park, Maplelake, near Mentor, Minnesota.

The program started with a band concert, after which the company's president, J. O. Melby, gave a word of welcome and introduced the general manager, Thomas Vollom, who has managed the company for over eighteen years, as the chairman of the day.

Manager Vollom gave a short history of the company, telling of its organization in 1906 by eighteen farmers near Rindahl, Minnesota, who subscribed to one share of stock each at a par value of $30.00, making a total of $540.00; of these organizers stressing that it should be a co-operative company and of the struggle of the president, J. O. Rindahl; the secretary-manager, J. O. Hovland; the vice-president, Herman Loitten, and the fieldman, E. G. O. Hoglund, to build up the company the first few years.

He told of the company purchasing neighboring exchanges; Fertile in 1907, Erskine in 1908, McIntosh in 1909, Fosston in 1912, Oklee and Plummer in 1920, Goodridge in 1924, Beltrami and Grygla in 1926 and Shevlin and Bagley in 1928.

New exchanges were developed at Clearbrook, Gully and Winger in 1911, Mentor in 1912, Gonvick and Trail in 1913 and Lengby in 1915.

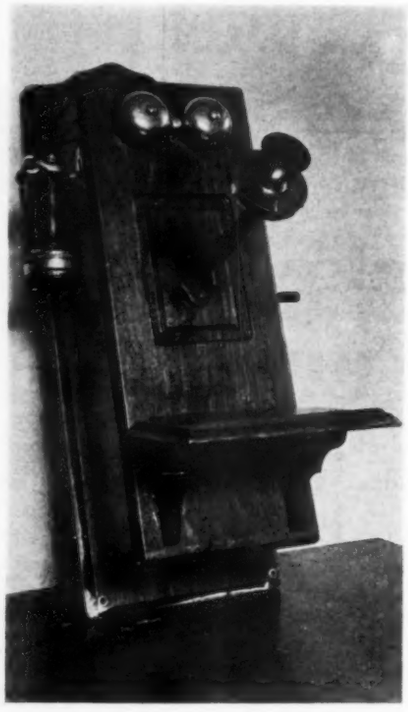
Bringing out the fact that the original investment was only $540.00, Mr. Vollom traced the growth of the company by giving the following statistics:

The company now operates in eight counties; has nearly 4,400 subscribers in twenty exchanges, of which 3,100 are rural subscribers. The number of stockholders is 2,750. The plant consists of 2,902 miles of poles, 4,431 miles of open wire and 23,170 feet of cable. Nineteen of the exchange buildings are company owned.

The book value of the plant on July 1st, 1931, was $303,978.73. The total company assets on this date were $318,439.76. The actual or immediate liabilities, $27,629.70. Capital stock outstanding, $129,810.00, leaving $160,999.97 as depreciation reserve and surplus.

He pointed out that although the rates of the company per telephone are $5.22 per year below the average the gross revenues for 1930 were $73,566.35. Had they been up to the state average the receipts would have been $95,960.00. To show the toll business done he stated that 96,063 toll calls had been originated and passed in 1930, giving an income of $14,329.50.

He closed by saying, "This company should from now on go forward with doubled strength. It is fully grown up and seasoned and has the experience of twenty-five years of pioneering to draw from in the future. It has been built up by farmers and small town business men, real folks, and around the axiom: to give as much service as possible, and as good service as possible, to as many as possible, as cheap as possible. If we keep this in mind at all times, those who may gather to celebrate the fiftieth anniversary, 25 years from now, shall remember us with thanks."



First Stromberg-Carlson telephone installed by the Garden Valley Telo. Co., in 1906. The instrument has been in constant use and is still in first class condition.

The Hon. C. G. Selvig, congressman for the ninth Minnesota district, just back from a tour of Europe, was among the speakers, as were the Hon. O. P. B. Jacobson, chairman of the board of railroad and warehouse commission of Minnesota, who pointed out that the Garden Valley company was the largest co-operative telephone company in the world and that in all dealings between the commission and the company he had experienced nothing but the most cordial and pleasant relations; J. O. Rindahl, first president of the company; and the Hon. J. H. Hay, assistant commissioner of agriculture for Minnesota. Mr. Hay has charge of the fostering of cooperative enterprises in the state. He said that the progress of the Garden Valley company was so outstanding and the efficiency of management so marked that it was one of the high peaks in the history of the northwest.

W. C. Caldwell, district representative of the Stromberg-Carlson Telephone Manfacturing company, and Mrs. Caldwell attended the picnic as a special representative of his company. The Garden Valley Telephone company has for the last eighteen years bought and used Stromberg-Carlson switchboards and telephones exclusively.

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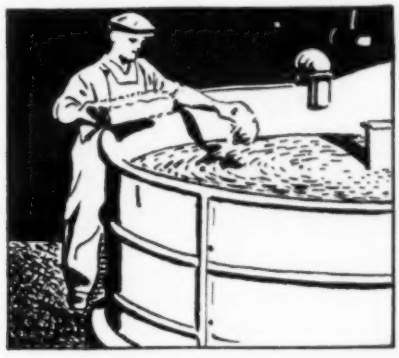
Your magazine is improving every month. I find the chapters by K. W. Graybill and B. C. Burden especially interesting.

I would like to read an article in TELEPHONE ENGINEER by some qualified engineer of the Teletype corporation who would write a detailed description and method of operation of the telephone typewriter.

Awaiting the arrival of the two books, I remain,

Very truly yours,
H. Mead Palmer.



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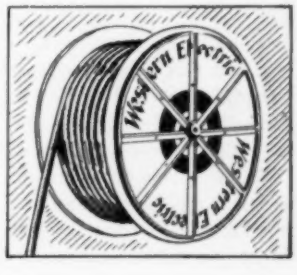
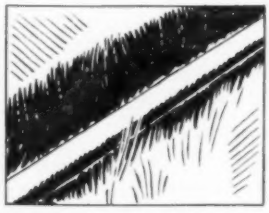
This innovation follows by little more than a year Western Electric's introduction of cable that can be laid directly in the ground—an invaluable feature under many conditions.

For full data regarding Western Electric cable made by the new process, get in touch with the nearest office of the distributor, Graybar Electric Company. There are 76 of these offices in different cities throughout the country. There is one near you.





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Methods for Locating Resistance Faults

The Bridge Methods Described Here by T. C. Henneberger and P. G. Edwards Are Better Adapted to Toll Than Exchange Telephone Cable Plant, Since They Require That Conductor Resistances of Wire Used for Measurements Be Equal, and That Measurements Be Made from Each End of Faulty Cable.

(In this paper are discussed bridge methods for locating resistance faults on cable wires, with special reference to the theory of methods for (1) locating insulation faults which cause complete cable failure, (2) locating insulation faults of high resistance, and (3) locating series resistance unbalances. The methods described are better adapted to the toll than to the exchange telephone cable plant, since they require that the conductor resistances of the wires used for measurements be equal and, in general, that measurements be made from each end of the faulty cable.)

In the toll telephone plant, insulation faults such as "grounds" and "crosses" are usually located by the "Varley loop" method, which involves essentially the measurement of the d.-c. resistance of the faulty wire between the point of fault and one end of the cable, and the comparison of this resistance with the total conductor resistance of the wire to obtain the "percentage location" of the fault on a resistance basis. Corrections are then applied to account for such factors as the resistance of the leads between the cable and the bridge, the resistances of loading coils, and non-uniformity of conductor resistance caused by temperature differences between underground and aerial sections of the cable. After all corrections are applied the corrected percentage location is converted into distance from one cable end to the fault.

In general, the most troublesome insulation fault to locate is a "wet spot" due to absorption of moisture by the insulation through a defect in the lead covering of the cable, which results in low insulation resistance between wires and to ground. Standard apparatus now available for locating grounds and crosses is sufficiently sensitive to permit accurate locations of wet spots up to about five megohms in resistance. The Varley loop methods ordinarily employed in connection with the apparatus will give accurate results provided a wire of very much higher insulation resistance than the faulty wire is used as the "good" wire for measurements. These are the conditions which usually are found when wet spots occur. Cases occur occasionally, however, in which a "good" wire having sufficiently high insulation resistance as compared to the faulty wire cannot be obtained, either because all of the wires available for measurements are affected by the fault or because the fault resistance is high. The methods for locating insulation faults discussed in this paper are especially applicable to such cases.

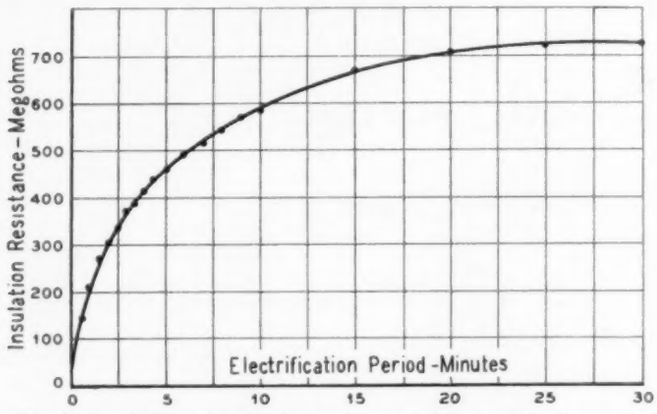

Fig. 1—Variation of insulation resistance with electrification period typical 50-mile aerial cable pair.

Resistance unbalances on cable wires are of relatively infrequent occurrence and are usually difficult to locate. A method frequently employed for locating such faults is to measure the impedance unbalance at various frequencies of a circuit containing the faulty wire and to analyze periodic impedance-frequency curves plotted from the measurements.[1] The methods for locating series resistance unbalances discussed in this paper involve the use of ordinary Wheatstone bridges, are simple to apply, and give results which are believed to be comparable to those obtained by the impedance-frequency method.

Insulation Resistance of Wires

The value of insulation resistance obtained by measurements on cable wires which are not faulty are dependent on the circumstances in which the measurements are made. In the case of paper-insulated telephone cable the most important factors affecting insulation resistance are electrification period and temperature.

The following discussion of normal insulation resistance refers particularly to measurements between wires of pairs in a typical repeater section of aerial toll cable approximately 50 miles long, the wires being at ground potential at the time of application of the testing potential. Insulation resistance to ground is also of interest, but is difficult to measure accurately in long lengths of cable because of interfering potentials. As a

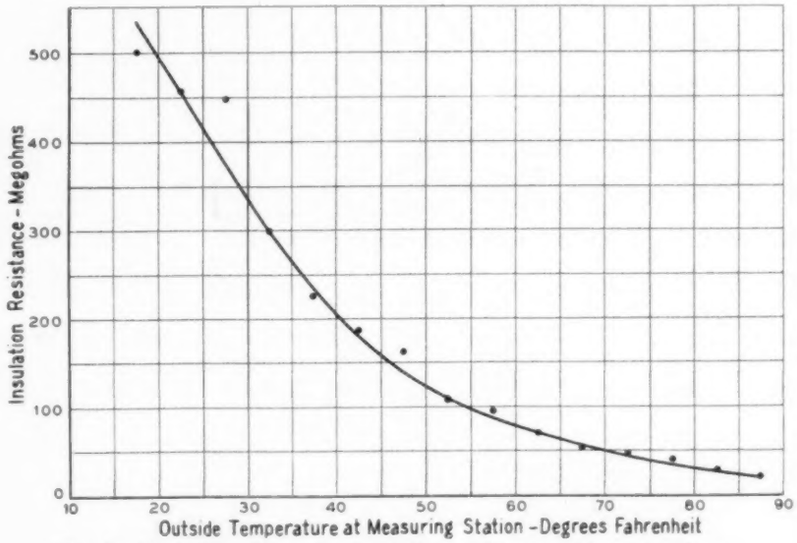

Fig. 2—Variation of average insulation resistance with temperature—typical repeater section of aerial cable.

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rough approximation, normal insulation resistance between a wire and ground can be considered to be about two-thirds as great as normal insulation resistance between wires.

A curve illustrating the variation of insulation resistance between wires of a typical cable pair over a 30-minute electrification period is shown in Fig. 1. In general, the electrification periods necessary for obtaining reasonably constant values of insulation resistance differ appreciably for different pairs, and for the same pair at different times. The usual period ranges from 15 minutes to an hour for a pair 50 miles long. Routine measurements are generally made, however, using electrification periods of one minute.

The paper used for insulating the wires of telephone cable has an appreciable negative temperature coefficient of insulation resistance. This is indicated by the curve of Fig. 2 which shows variations of average insulation resistance with temperature. The points for the curve were obtained by averaging, for each five-degree range of temperature, the insulation resistances obtained by measurements made daily over the course of a year on representative pairs in a repeater section, using electrification periods one minute long. It has been found that the percentage change in insulation resistance per degree change in temperature differs widely for different cable sections and even for the individual pairs in a particular section. The average change per degree Fahrenheit is probably about four per cent, for the temperature range encountered in the plant.

The curves of Fig. 3 illustrate comparative variations of insulation resistance between wires of a representative cable pair, conductor resistance of the pair, and outside temperature, during a 24-hour period which included a late autumn day. The curves were plotted from measurements being made every half hour, one-minute electrification periods being used when measuring insulation resistance. It is not uncommon to find that the insulation resistances of particular pairs vary by factors of three to one during the course of a day.

Comparative variations of average insulation resistance between wires of pairs and of mean outside temperature over the course of a year are illustrated by the curves of Fig. 4. The points for the insulation resistance curve were obtained by measuring the insulation resistances of a number of pairs each working day during the year, using one-minute electrification periods, and averaging the measured values for each day.

In general, average insulation resistance is likely to vary by a factor of 15 to one during the course of a year. Individual pairs are, of course, subject to much wider seasonal variations in insulation resistance. During winter it is not uncommon to find particular pairs in a 50-mile repeater section with insulation resistances between wires of several thousand megohms, while during the summer, especially in cables which have been in service for a number of years, the insulation resistances between wires of some pairs in a 50-mile repeater section may be as low as 25 megohms (1250 megohm-miles).

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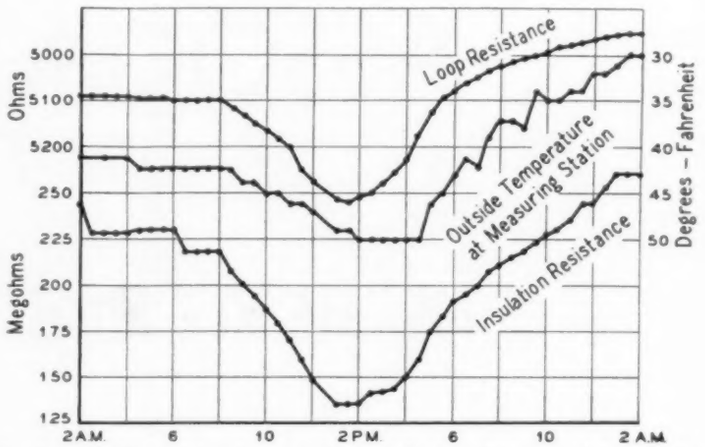


Fig. 3—Variation of insulation resistance, loop resistance and temperature over 24-hour period—typical 50-mile aerial cable pair.

[1] "Telephone Circuit Unbalances," by L. P. Ferris and R. G. McCurdy, A. I. E. E. Transactions, 1924, Volume XLIII, page 1331.

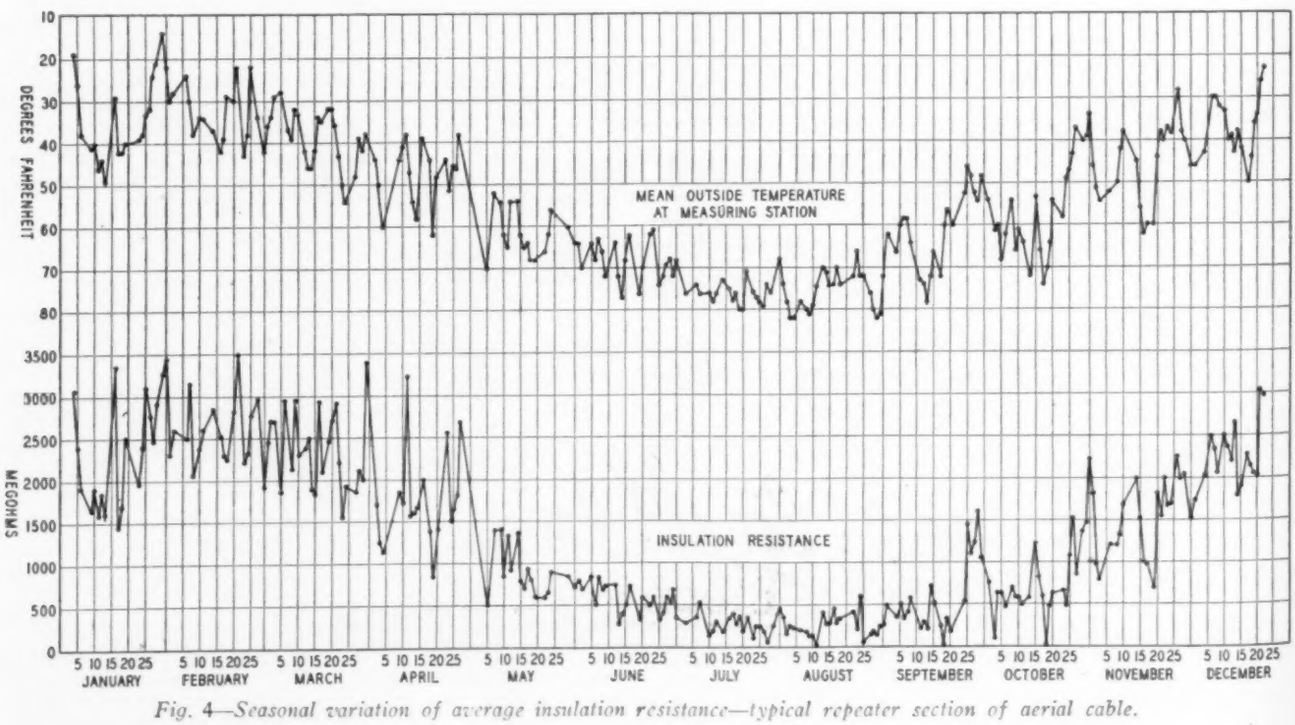


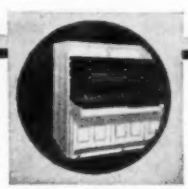
Fig. 4—Seasonal variation of average insulation resistance—typical repeater section of aerial cable.

NEW and LARGER QUARTERS

. . . . . for a GROWING ORGANIZATION

EFFECTIVE Oct. 1, 1931, American Electric Company, Inc., will occupy its new factory and general offices at 6126 S. La Salle St., Chicago. These new quarters provide an increase of more than 42,000 square feet of floor space for the company's growing business of telephone equipment manufacturing. New warehouses in connection will also facilitate the distribution of American Electric's complete line of construction materials, tools and supplies.

At the same time, the Kansas City offices and warehouse of American Electric Company, Inc., will be removed to new and more modern quarters at 2025 Main St., Kansas City, Mo. May we ask that you bring these new addresses to the attention of those members of your organization who are not likely to see this announcement—as correctly addressed correspondence will enable American Electric Company, Inc., to maintain its enviable reputation among telephone companies for quick, accurate and dependable service.



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Varley Loop Method

The Varley loop circuits which are used ordinarily for locating grounds and crosses on wires of toll cable are illustrated in Figs. 5 and 6. The Wheatstone bridge has equal ratio arms, A. The "good" and faulty cable wires have equal conductor resistance, r, and are connected together at the distant end of the cable. F is the resistance of the fault, and x is the conductor resistance of the faulty wire between the fault and the distant end of the cable.

With the battery switch in "Varley" position, a Varley measurement is made by balancing the bridge to a rheostat value, V, at which there is no galvanometer current. Then:

$$\frac{A}{A} = \frac{r+x}{r-x+V}$$

$$x = \frac{V}{2}. \qquad (1)$$

It will be noted that the fault resistance, F, is in series with the battery and has no effect on the measurement except to limit the sensitivity of the bridge.

With the battery switch in "loop" position, a loop resistance measurement is made by balancing the bridge to a rheostat value, L. Then:

$$r = \frac{L}{2}.$$

From these Varley and loop measurements the percentage location of the fault, on a resistance basis, can be calculated as follows:

From the distant end: $\frac{V}{L}$ (100 per cent).

From the measuring end: $\frac{L-V}{L}$ (100 per cent).

Corrections for resistances of bridge leads, loading coils, etc., are then made, the corrected percentage location is converted into feet, and the location of the fault is determined by reference to cable records.

These Varley circuits and formulas are well adapted to the toll cable plant where wires are usually well balanced in conductor resistance, and the resistance of the leads between the bridge and the cable is small compared to the conductor resistance of the cable wires. In exchange cable work, modified forms of the Varley loop, which do not require that the "good" and faulty wires be of equal conductor resistance and which correct automatically for the resistance of bridge leads, are frequently used.

Total Cable Failures

In the case of total cable failure due, for instance, to a wet spot, there are no wires in the cable which are unaffected by the falt, and the fault resistances of a large number of the wires are low, i. e., of the same order of magnitude as the conductor resistances of the wires. Two methods by which such faults can be located are discussed below: A "Corrected Varley" method which may be used provided two wires having fault resistances to ground differing by at least 25 per cent are available for measurements; and a "Straight Resistance" method which does not require that the two wires have faults of unequal resistances.

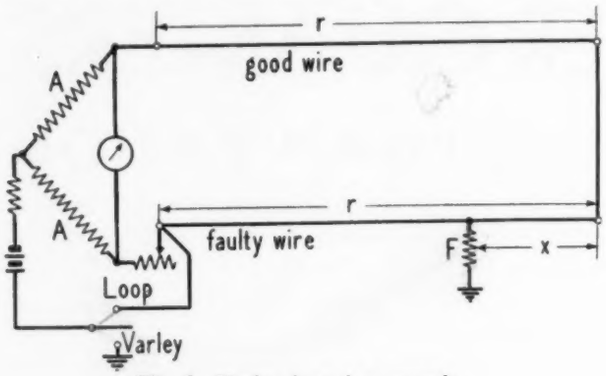


Fig. 5—Varley loop for grounds.

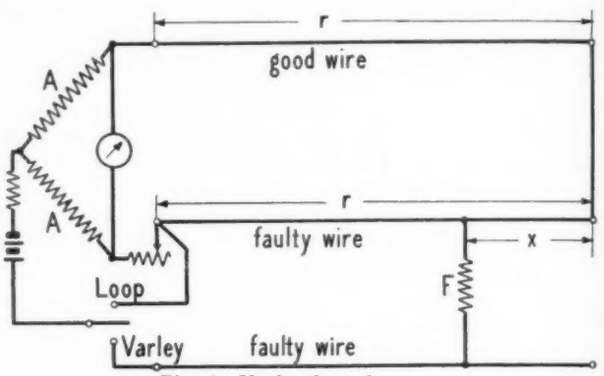


Fig. 6—Varley loop for crosses.

Corrected Varley Method

Consider a cable in which all wires have low insulation resistance to ground because of a wet spot, and assume that from among the faulty wires two wires are selected for a Varley measurement. Assuming a bridge having equal ratio arms, A, the Varley network can be represented as shown in Fig. 7, where M and F are the effective resistances of the faults on the two wires, r is the conductor resistance of either wire, and x is the resistance of that portion of either wire which is between the distant end of the cable and the faults.[2]

The Varley circuit of Fig. 7 is equivalent to the Varley circuit of Fig. 8, where the "π" type network formed by the three resistances, M, F and $2r$, has been replaced by a "T" type network having resistance values as indicated. When the bridge is balanced by adjustment of the rheostat to a resistance, V, at which there is no galvanometer current:

$$r - x + \frac{2Mx}{M = F + 2x} =$$

$$r - x + \frac{2Fx}{M = F + 2x} + V.$$

Solving for x:

$$x = \frac{V}{2} \frac{(M+F)}{(M-F-V)}. \qquad (2)$$

Comparison of this formula with Formula (1) indicates that the factor $V/2$, as determined by Varley measurement, represents the apparent rather than the true resistance between the distant end of either wire and the location of the faults. The factor $\frac{(M+F)}{(M-F-V)}$ is a correction factor and expresses the relation between $V/2$ and the true resistance, x. If the fault, M, is very much higher in resistance than either the fault, F, or the balancing resistance, V, the correction factor becomes practically equal to one and $V/2$ becomes practically equal to x. In these circumstances the wire having the fault, M, can properly be called a "good" wire and Formula (1) will give accurate results.

Since the apparent resistance, $V/2$, can be determined by Varley measurement the faults can be located if the value of the correction factor can be determined. The correction factor can be evaluated by additional measurements made on the two faulty wires from the end of the cable opposite to that used for the Varley measurement, as described below.

Referring to Fig. 7, the resistance of either wire between the faults and the end of the cable opposite to that used in making the Varley measurement is x. If a loop resistance measurement is made from this opposite end, using a bridge having equal ratio arms, *with the distant ends of the wires open*, and the resistance

[2]The actual faults form a "π" type network consisting of a resistance between wires and a resistance between each wire and ground. The "π" type network has been replaced by a "T" type network having resistances, M and F, between the two wires and the branch point of the network, and a third resistance connecting the branch point to ground. This third resistance is in series with the bridge battery and its only effect is to limit the sensitivity of the bridge. To simplify discussion the resistances, M and F, are shown connected directly to ground, and the third resistance is considered to form a part of the resistance shown connected between the battery and the junction point of the ratio arms of the bridge.

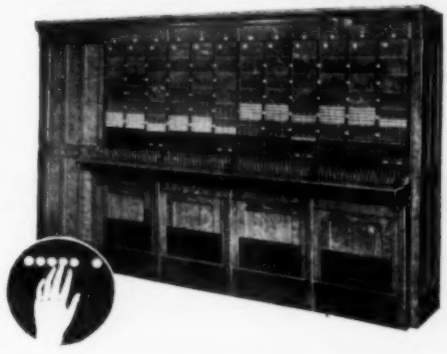
PROFITS *in* CONVERSATION

Satisfactory conversations are the telephone company's assurance of profit.

The correct subscriber instrument is an important link in the satisfaction the subscriber gets from his telephone service.

Stromberg-Carlson Central Energy Telephones, desk and hand set types, are so efficient that subscribers enjoy them. They are equipped with the Booster Talking Circuit which insures the maximum transmission efficiency.

The Stromberg-Carlson hand set is light and shaped so that one naturally holds it in a position to speak directly into the mouthpiece. Stromberg-Carlson engineers will be pleased to furnish you with details.



Features of the Stromberg-Carlson Super-Service Switchboard

Advance Plugging-In
Operator's Listening Indication
Operator's Secret Service
Audible Busy Tests
Reverting Busy Test with Tone
Operator's Ringing Control
Instantaneous Ringing Start
Instantaneous Ringing Cut-Off
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Visual Ringing Indication
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Write for Bulletin 115.

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Southern Representative
Scoville Mercantile Company,
Atlanta, Ga.

PAUL D. MYERS, INC., 333 North Pennsylvania Street. Indianapolis, Indiana Representative

Stromberg-Carlson

in the bridge rheostat at balance is designated L_o:

$$M + F = L_o - 2x.$$

If a Varley measurement is made from the same end, using a bridge having equal ratio arms, *with the distant ends of the wires open*, and the resistance in the bridge rheostat at balance is designated V_o:

$$M - F = V_o.$$

Substituting these values of $(M + F)$ and $(M - F)$ in (2):

$$x = \frac{V}{2} - \frac{L_o}{V_o}. \qquad (3)$$

Application: To apply the Corrected Varley method, an ordinary Varley measurement is made from one end of the cable, and additional loop resistance and Varley measurements, as described above, are made from the opposite end. The values of balancing resistance thus obtained are substituted in Formula (3). The location of the trouble on a resistance basis, x/r, can then be calculated, and the location can be converted into feet in the usual manner.

Usually it will be necessary to determine the loop conductor resistance, $2r$, of the faulty wires from cable records rather than by measurement at the time the location is being made. A measurement of loop conductor resistance would be in error because of the low resistance shunt $(M + F)$ on the portion of the loop between the faults and the short-circuited ends of the wires. The accuracy of location is dependent, therefore, on the accuracy to which conductor resistance can be estimated.

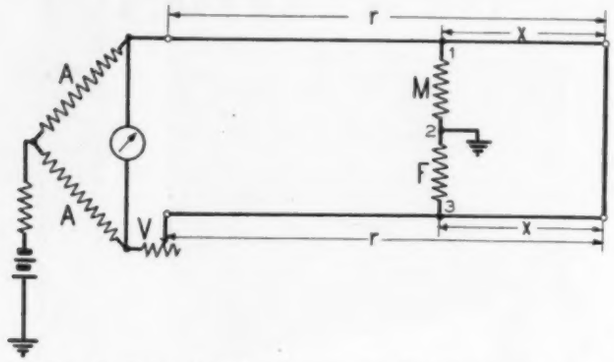

Fig. 7—Schematic circuits—corrected Varley method.

In cases where it is desirable to use the Corrected Varley methods the fault resistances will be low, so that usually the balancing resistance, L_o, will not exceed 10,000 ohms If L_o is too high to measure using a bridge with equal ratio arms, unequal ratio arms, A and B, may be used and the quantity $\frac{A}{B} L_o$ substituted for L_o in Formula (3). Measurement of V_o, however, should be made using a bridge with equal ratio arms.

The Corrected Varley method will give accurate results only under the following conditions:

(1) Both faults must be at the same point along the cable.

(2) The fault resistances must remain constant throughout the test.

(3) The resistance of the fault on one wire must be higher than the resistance fault on the other wire.

(4) The conductor resistances of the faulty wires must be equal.

In the practical application of the method, care must be exercised in selecting the wires to be used for measurements. The resistance, M, of the fault on the wire which is connected to the ratio arm of the bridge when measuring V should be appreciably higher (at least 25 per cent higher) than the resistance, F, of the fault on the wire connected to the rheostat arm of the bridge. This can be understood by considering that as M and F approach each other in value the correction factor becomes larger and the Varley balancing resistance, V, approaches zero, i. e., the apparent location of the trouble approaches the distant end of the cable. Errors in measurement become increasingly important as V and V_o become smaller.

Accurate results will not be secured if the resistances of the faults vary while a set of measurements to determine V and the correction factor is being made. It is advisable, therefore, to make a number of separate sets of measurements, and to base the location on those sets which appear to be consistent.

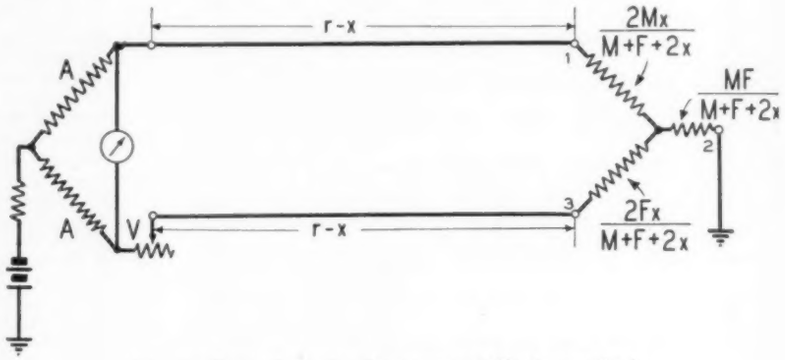

Fig. 8—Equivalent circuit—corrected Varley method.

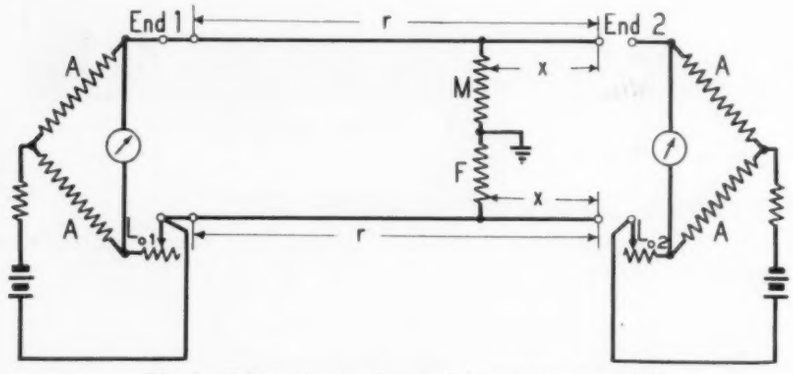

Fig. 9—Schematic circuit—straight resistance method.

Straight Resistance Method

In many cases of complete cable failures the faults on all of the wires are of practically equal resistance, and the Corrected Varley method cannot be used successfully. The Straight Resistance method described below has the advantage that the wires used for measurement need not be unequal in fault resistance.

The Straight Resistance method is based on the assumptions that the wires on which the tests are made are of equal conductor resistance, that the fault resistances are comparable in magnitude to the conductor resistances, and that the fault resistances remain constant while a set of measurements is being made.

Referring to Fig. 9, assume that, from among the faulty wires, two wires are selected having a fault of low effective resistance $(M + F)$, between wires. Let r be the conductor resistance of either wire between cable Ends 1 and 2; and let $(r - x)$ and x be the conductor resistances of either wire from Ends 1 and 2, respectively, to the fault.

(*Continued on page* 48.)

Many More Service Hours

YOU'RE not interested in what's in a battery, nor how it's made—you want *hours of service*. Ray-O-Vac Telephone Batteries give you *many more* hours of service, as proved by tests conducted in accordance with U. S. Government standards, and by records of users. It's this longer life that makes the service-hour cost of Ray-O-Vac Batteries so remarkably low, and decreases service expense. Put Ray-O-Vac Batteries to work, and you'll find that Ray-O-Vac's longer life means real battery economy.

The quality that makes for better, longer service in Ray-O-Vac Telephone Batteries is characteristic also of Ray-O-Vac Flashlight and Ignition Batteries, and Ray-O-Vac Rotomatic Flashlights.

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Manufacturers of Ray-O-Vac Rotomatic and Standard Flashlights; Ray-O-Vac Flashlight, Radio, Autoradio, Aircraft, Telephone and Ignition Batteries; Ray-O-Vac Radio Tubes.

RAY-O-VAC

New Home For American Electric

Moves to New and Larger Quarters, Constructed to Provide Maximum of Daylight, Conveniently Close to Railroads

Two new addresses have been announced by the American Electric Company, Inc. Its headquarters in Chicago have been moved to a new and larger building at 6126 South La Salle street. The Kansas City branch office and warehouse has also changed to a new location at 2024 Main street, Kansas City, Mo.

Officials of the company state that the new home of the American Electric company in Chicago will provide increased space for every department of the organization. The new building is U-shaped, with an interior court providing exceptionally good light and manufacturing. It is claimed that daylight is particularly important in many phases of telephone equipment manufacture.

The plant is particularly advantageously situated in the matter of location, being within a few hundred feet of the junction of four important railroads, the New York Central, the Pennsylvania, the Nickel Plate, and the Rock Island systems. This fact, coupled with increased warehouse space in the new building, will be of untold value, it is believed, in giving telephone companies quick service.

METHODS FOR LOCATING RESISTANCE FAULTS

(*Continued from page 46*)

With the wires open at End 2, the resistance between wires is measured at End 1 by means of a bridge having equal ratio arms and arranged for an ordinary loop resistance measurement. Calling the rheostat resistance at balance, L_{01}:

$$L_{01} = 2(r - x) + (M + F).$$

Similarly, with the wires open at End 1, the resistance between wires is measured at End 2. Calling the rheostat resistance at balance, L_{02}:

$$L_{02} = 2x + (M + F).$$

Combining the equations for L_{01} and L_{02}:

$$L_{02} - L_{01} = 4x - 2r.$$

and therefore:

$$x = \frac{2r + (L_{02} - L_{01})}{4}, \quad (4)$$

$$(r - x) = \frac{2r - (L_{02} - L_{01})}{4}. \quad (5)$$

Application: The Straight Resistance method involves only simple resistance measurements, L_{01} and L_{02}, from the two ends of the cable. The loop conductor resistance of the faulty wires is obtained from cable records. The values thus secured are substituted in Formula (4) or (5), and the location, x or $(r - x)$, is converted into feet in the usual manner.

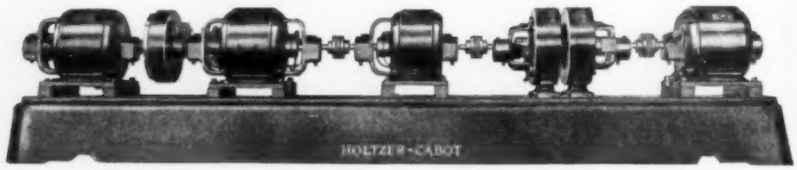
Since the conductor resistances of the faulty wires must be equal, measurements should be made on the two wires comprising a pair when practicable. The effective fault resistance between wires should be low; otherwise slight errors in measurement might cause large errors in calculated location. However, in cases where the fault resistances are too high to be measured using bridges with equal ratio arms, unequal arms, A and B, may be used and the quantity $\frac{A}{B}(L_{02} - L_{01})$ substituted for $(L_{02} - L_{01})$ in the formulas.

In connection with both the Corrected Varley method and the Straight Resistance method, it is possible to modify the measuring schemes and obtain somewhat more complicated formulas for the location of the faults. The specific measuring schemes which have been described are those which it is felt are most practicable for fault locating working on toll cable.

(*To be continued next month.*)

Do You Use the Harmonic System of Ringing?

If so, you will be interested in reading our BULLETIN 302-D, SUPPLEMENT C, describing an—



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having an absolute generator speed control by means of a newly developed ELECTRO-MAGNETIC COUPLING.

One of these machines will be on display in Booths 25-26, in the Stevens Hotel, Chicago, during the COMING TELEPHONE CONVENTION.

The Holtzer-Cabot Electric Company
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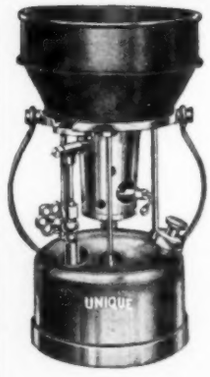

TEN MINUTES

to melt 50 pounds of solder! Couple this feature to the strength and simple design of all UNIQUES — and you have the reason it's preferred in the telephone field. We'll send it on trial. Write—

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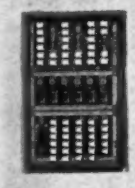

JAMAICA

Above: Main Exchange Building at Kingston, Jamaica. At Left: Strowger Automatic Exchange Building at Half-Way Tree, Jamaica.

Jamaica Modernizes Its Telephone System--- With Strowger Automatic

THE above views show two handsome exchange buildings of the Jamaica Telephone Company, Ltd., and strikingly illustrate the progress which has been made by this aggressive organization in furnishing its patrons with the finest telephone service available.

At Half-Way Tree, 700 lines of Strowger Automatic equipment are installed, providing telephone users in this area with full automatic service. At Kingston incoming second selectors and connectors are installed, allowing calls originating at Half-Way Tree to be completed into Kingston on a full automatic basis. Local Kingston calls are still completed manually, but it is proposed to convert this exchange to a full automatic basis at an early date.

The program to convert the Jamaican telephone system to a full automatic basis is in line with similar undertakings in all parts of the world. Regardless of climate, humidity, or language difficulties, Strowger Automatic operation has proved to be highly successful wherever adopted. Write now for prices and tenders on the application of this modern system to your properties, as well as information and prices on any other type of telephonic or signalling equipment of which you may be in need.

SUPPLIERS OF THE FOLLOWING PRODUCTS

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STROWGER AUTOMATIC TELEPHONE SYSTEMS

MANUAL TELEPHONE EQUIPMENT

ALTON STORAGE BATTERIES

PHILLIPS WIRES AND CABLES

ELECTRICAL MEASURING INSTRUMENTS

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and other high quality products in the signal and communication field.

THE AUTOMATIC ELECTRIC COMPANY, LIMITED

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DISTRIBUTING COMPANIES

In Canada · Independent Sales and Engineering Company, Ltd., Vancouver
In Australasia · Automatic Telephones Ltd., Sydney
In Japan · Automatic Telephones Ltd. of Japan, Tokyo
In China · Automatic Telephones of China Federal Inc., U. S. A.
In South Africa · Automatic Telephones (South Africa) Ltd., Johannesburg

ANTWERP, BELGIUM

ASSOCIATED COMPANIES

Automatic Electric Inc., Chicago
American Electric Company, Inc., Chicago
International Automatic Telephone Co., Ltd., London
Automatic Telephone Manufacturing Co., Ltd., Liverpool
The New Antwerp Telephone and Electrical Works, Antwerp
Eugene F. Phillips Electrical Works Limited, Montreal

News From the Field

The Wisconsin Telephone company is placing a new submarine cable on the bottom of the Fox river to replace the old one. New composite and aerial cable being installed contains 202 pairs of wires protected against moisture by a heavy lead sheath. The length of the underwater span is 600 feet.

The DeKalb-Ogle Telephone company together with the Illinois Northern Utilities company are moving poles off the main streets of Oregon, Ill., and placing them in alleys wherever possible.

Each city and village in Wisconsin served by the Wisconsin Telephone company has been asked to appropriate a sum equivalent to 15 cents per telephone to pay the cost of local investigation of charges made by the telephone company with a view to possible rate reductions, according to a decision reached by a committee of the League of Wisconsin Municipalities.

Michigan Associated Telephone company, a subsidiary of the Associated Telephone Utilities company, has added more than 1,500 telephones to its lines, as the result of a sales campaign to secure new subscribers.

The Princeton Telephone company, Princeton, Ill., is enclosing underground wires in tile in order that repairs can be made without digging into the street. With the wires enclosed in tile they may be pulled out for repairs.

There was a net increase of 112 telephones during August in Shreveport, La. According to the manager of the Southern Telephone & Telegraph company, this was more than a seasonal increase and the largest gain of the year.

Improvements in Hillsdale, Ill., by the Crescent Telephone company, costing $3,000, have been completed. Almost the entire system is now metallic, with a two-wire system instead of the old one-wire system.

A new radio program sponsored by the American Telephone & Telegraph company is being planned for broadcasting in the eastern part of the United States, according to the Columbia Broadcasting System, which will handle the program. If successful it may be extended to a coast-to-coast hookup, according to officials of the telephone company. Under the title "Music Along the Wires" the telephone company will present a symphony orchestra and vocal ensemble.

Directors of the International Telephone & Telegraph company have reduced the annual dividend rate to $1 annually, declaring a 25-cent dividend for the quarter. Previously dividends had been paid at the rate of 50 cents quarterly.

The Inter-County Telephone company, Gallatin, Mo., has installed a new magnetic type switchboard at the Gallatin exchange.

The Rochester Telephone company, Rochester, Ind., has announced plans to place all lines within city limits underground, while those stretching out of the city will be replaced with aerial cable.

Expenditure of $2,958,880 on improvements has been authorized by the board of directors of the New York Telephone company, according to J. S. McCulloch, president.

Employment of about 400 persons to sell telephone service and extensions on commission throughout area served by the New York Telephone company has been completed. This policy has been adopted on a widespread basis through large cities served by the American Telephone & Telegraph company.

Because of the great distance between houses the state of Minnesota has provided roadside telephones on the so-called airline highway through the upper part of the state.

The Home Telephone company of Trenton, Tenn., has been sold to the Southern Bell Telephone company at a price near $15,000. The sale waits approval by the utilities commission and the interstate commission before it becomes official. J. W. Moore is manager of the Home Telephone company.

Reports from McPherson, Holton and Marysville, Kans., indicate that the opening of school this year in the Kansas counties of McPherson, Jackson and Marshall finds a marked increase in the number of school telephones over previous years. The Colorado school bus tragedy last winter is believed to be the cause of the increase in rural school telephones.

A district telephone meeting was held September 23 at the Y. M. C. A. building at Decatur, Ill. More than 100 representatives of telephone companies in 23 counties were in attendance. A large class of operators attended a school of instruction conducted in the Decatur club building while the convention was in progress.

The Wisconsin Telephone company's new long distance cable is now in service between Appleton and Stevens Point. The cable is the newest link of the proposed Milwaukee-Minneapolis long distance line.

The Dakota Central Telephone company of Mitchell, S. D., plans to erect a brick and steel exchange building at a cost of approximately $20,000.

P. Kerr Higgins, president of the Scotia Telephone company, University City, Mo., and one of the leaders in the Independent telephone field, completed fifty years of service in the telephone industry in September.

A new interlocking telephone system has been installed in the post office at Knoxville, Tenn. The new equipment will enable the postmaster to communicate with all departments, and the heads of various departments may keep in touch with each other.

The largest number of trans-Atlantic telephone calls ever put through on one business day were recorded on Monday, September 21, when between 140 and 160 calls were made. The record day was Christmas, 1925, when 165 calls were made.

New telephone cables are being placed in Elkhart, Ind., by the Southern Indiana Telephone company.

An advertisement in the Athens Messenger, Athens, Ohio, by the Athens Home Telephone company, is headed "Business Recovery Indicated by the Addition of 100 New Subscribers During July, August, September, 1931." Beneath this caption is a directory of the new subscribers to be attached to the telephone book for reference.

KANSAS ASSOCIATION PLANS SEVEN CONFERENCES

The annual fall district meetings of the Kansas Telephone association will begin October 6 and continue throughout October 15, according to A. R. MacKinnon, secretary.

Seven different meetings will be held during that time at seven different Kansas towns as follows: Wichita, October 6; Pratt, October 7; Hays, October 8; Erie, October 13; Osage City, October 14, and Holton, October 15.

RAY BLAIN'S NAME LISTED IN WHO'S WHO

Ray Blain, well known telephone man, at present connected with the office of the chief signal officer, War Department, Washington, D. C., and author of many technical articles for TELEPHONE ENGINEER, is among those listed in the 1931 Who's Who in Engineering.

Long or short, every toll call is measured down to the quarter of a minute

In the rapid flow of traffic through the nation's toll boards, *the duration of each call is purely accidental.* Of long or short duration, they follow on the heels of one another in such swift succession that the elapsed time of each would be simply lost—beyond any power of calculation—if it were not for the Calculagraph. This precision instrument *is the only time meter capable of automatically computing elapsed toll time.*

The Calculagraph stamps on the toll ticket the beginning of each call together with the time elapsing during each call, *down to the quarter of a minute,* for any number of calls—producing a permanent and acurate record of each.

Price and Information on Request

THE CALCULAGRAPH COMPANY
50 Church Street Dept. 22 New York City

CALCULAGRAPH
THE ELAPSED TIME RECORDER

Thrifty Bill Says
"You can pay more but you cannot buy better insurance."

REDUCE YOUR INSURANCE COSTS BY DEALING DIRECT WITH TELEPHONE INSURANCE HEADQUARTERS

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A post card will bring you the figures

LYNTON T. BLOCK & CO.
ST. LOUIS, MO.
UNDERWRITERS OF SELECTED CLASS INSURANCE
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Specialized Insurance for Telephone Companies

A COMPLETE TELEPHONE EQUIPMENT SERVICE FOR CANADA...

Everything a telephone company could use—telephones, both automatic and manual, automatic and manual switchboard equipment, construction materials, wires, batteries, supplies—are kept in stock by us. We are prepared to fill every requirement—promptly—with well-known products, noted for their unvarying standards of high quality.

Besides this, we have our own manufacturing and repair facilities—each department manned by experts highly skilled and experienced in their particular specialty. No matter whether you anticipate the modernization of a small rural exchange or the installation of a complete metropolitan telephone system, we are prepared to handle the undertaking in its entirety. Secure prices and proposals from us before making your next purchase—they will be gladly furnished upon request.

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ALTON BATTERY COMPANY, Alton, Eng.

Apartment Installs Kellogg P. B. X.

Detroit's Co-operative Alden Park Manor Adds P.B.X. Switchboard and 350 Masterphones to Complete Its Superior Service

Set in an emerald-green park overlooking the Detroit river, is Alden Park Manor, a gigantic co-operative apartment of four eight-story buildings grouped together and under one management.

Homes in this unusual apartment building are sold outright to tenants. Each tenant owns his own home and pays a certain sum monthly to cover the cost of heat, light, gas, refrigeration, service, and up-keep of the building. The buildings are all well planned and beautifully constructed. Fronting the river adjacent to the Detroit yacht basin, home owners in Alden Park Manor are ideally located. Richly furnished interiors convey an atterests of economy and better service, a Kellogg single position 400 line P. B. X. was installed to handle all inter-communication traffic. Three hundred and fifty Kellogg masterphones were installed in the apartments and wired. Masterphones were chosen for their excellent tone qualities and because their attractive lines harmonize so well with the modern appointments of Alden Park Manor apartments.

The masterphones were wired direct to the P. B. X. and all inside calls are handled by operators maintained by the building corporation. Outside calls are handled by an entirely separate system

Alden Park Manor, a fine co-operative apartment development located on the Detroit River, Detroit, Mich., recently installed a Kellogg P. B. X. and 350 Masterphones.

mosphere of warmth and comfort. An artistic lobby with a uniformed attendant, leads to the entrance of all buildings. Large underground garages give residents a convenient place to keep their cars. In the basement and on the first floor various stores are located so that shopping may be done without leaving the building. All in all, Alden Park Manor represents the utmost in modern convenience and beauty.

There are 352 apartments in these buildings, ranging from three rooms up to almost any number of rooms desired. A telephone is installed in each of these apartments to care for all intercommunication calls.

After considerable deliberation by the manager and officers of the building corporation, a decision was reached to install a private switchboard. In the in- with lines running direct to the central office of the local telephone company. Outside telephones are installed only by request of the home owners while masterphone installations are permanent. Under this system telephone service has been fast, certain and satisfactory, and at the same time its cost has been reasonable. Everyone has expressed satisfaction with the new equipment and especially so with the new masterphone which has added a final note of distinction to the beauty of Alden Park Manor homes.

CLAIMS Z. M. A. RESIST FIRE

An interesting incident referring to the fire resistance of poles recently occurred on the C. B. & Q. railroad near Aurora, Ill. A fire on the right of way got out of control at a point where the telegraph department was rebuilding the pole line. A new Z. M. A. pine pole had been set about twelve inches from the old untreated cedar when the fire broke out and both of the poles were exposed to the flames. As shown in the photograph below, the untreated cedar

was badly damaged by the fire while the Z. M. A. pine was not charred in the least degree.

An interesting feature of this incident is that the fire spread the entire length of the untreated cedar pole, doing more damage at the extreme top of the pole including the cross arms, even than at the ground line. The new cross arms in the photograph on the Z. M. A. pine pole were not exposed to the fire as the reconstruction forces had not yet started transferring the wires when the fire occurred.

At first it was thought that the water content of the Z. M. A. solution was the fire resistant agency of the Z. M. A. pine but on investigation of this question it was found that while the fire occurred early in November, 1930, the pole had a 1929 Z. M. A. brand. As the branding in all cases is done at the time of treatment, the 1929 brand indicates that the pole had been in the seasoning yard at least 10 months including an entire spring and summer between the time of treatment and the fire.

CONVENTION SCHEDULE

U. S. Independent Telephone Association, Hotel Stevens, Chicago, October 20, 21, 22 and 23.

Independent Pioneer Telephone Association of U. S., Hotel Stevens, Chicago, Thursday, Oct. 22.

Missouri Telephone Association, Hotel President, Kansas City, November 11 and 12.

Illinois Telephone Association, Pere Marquette Hotel, Peoria, November 18 and 19.

A PERMANENT SAFETY FACTOR

If your lines are to give uninterrupted service, poles must always provide a full factor of safety to resist the severe tests of sleet and wind storms. That is why many utilities specify National Lumber and Creosoting Company Poles. Southern Yellow Pine for Strength, Pressure Creosoted so that Strength is retained through the years.

National Lumber & Creosoting Company

GENERAL OFFICES: TEXARKANA, ARK.-TEX.

SALES OFFICES
Texarkana, Ark. Houston, Tex.
Kansas City, Missouri
St. Louis, Mo. Denver, Colo. Superior, Wis.

TREATING PLANTS
Texarkana, Tex. Houston, Tex. Alexandria, La.
Finney (P. O. Col. Park, O) Kansas City, Mo.
Salida, Colo. Denver, Colo. Superior, Wis.

CONVINCE YOURSELF . . .

A typical cell of the Exide Chloride Battery so widely used in telephone service.

COMPARE ITS PERFORMANCE

THE real test of a telephone battery is performance. Not the performance of one or two years,—but of many years.

Is it dependable . . . free from trouble . . . durable . . . and economical over a long period of time? These are the important considerations when selecting telephone batteries.

Exide Chloride Batteries meet the strictest requirements. Their famous Manchester Positive and Box Negative plates assure dependability and long, useful life. Their design and careful construction minimize maintenance requirements, promote freedom from trouble, and assure economical operation.

The experience gained in designing and building batteries for the telephone industry during the last 36 years is behind every Exide Chloride Battery. It has been time tested in every branch of telephone battery service. Their cost is moderate.

Visit the Exide Booth, No. 41, U. S. Independent Telephone Association Convention, Stevens Hotel, October 20th to 23rd Inclusive.

Exide BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa.

World's Largest Manufacturers of Storage Batteries! or Every Purpose

THE TECHNICAL CLEARING HOUSE

B. C. BURDEN, Editor

Joint Use Plant

Q.—What vertical clearances are recommended between power and telephone plant on joint poles?

A.—The Bureau of Standards Handbook No. 10 titled "Safety Rules for the Installation and Maintenance of Electrical Supply and Communication Lines," specifies the following minimum clearances on joint plant:

	Minimum Voltage of Power Line	Vertical Clearance
Vertical clearance between power and telephone crossarms, center to center	0-7500	4′
Over	7500	6′
Vertical clearance between power and telephone conductors	0-7500	40″
Over	7500	60″
Vertical clearance between power equipment and telephone conductors	0-7500	40″
Over	7500	60″
Vertical clearance between telephone equipment and power conductors	0-7500	40″
Over	7500	60″

Loss Caused by Series and Shunt Resistance

Q.—Please explain the method of computing the loss in decibels due to inserting a series resistance in a line, or a shunt resistance across a line.

A.—The following figures and equations illustrate an easy method of determining loss caused by series or shut resistances in circuits.

It will be noted that it is necessary to know the value of the terminal impedances in arriving at the loss caused by the inserted resistance.

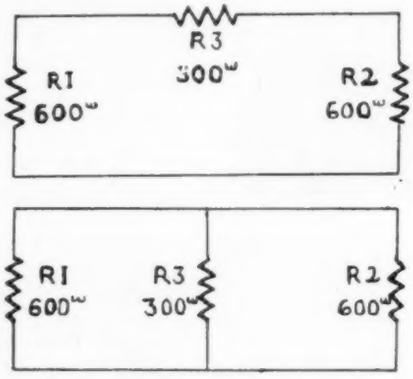
When: I_1 = relative current with R_3 out; I_2 = relative current with R_3 in.

To find loss due to inserting resistance R_3 between resistances R_1 and R_2, substitute the resistance values in the following equation and solve to find the ratio of the current under the two conditions.

For example:

$$\frac{I_2}{I_1} = \frac{R_1 + R_2}{R_1 + R_2 + R_3} = \frac{600 + 600}{1500} = 0.8$$

The loss in decibels due to the resistance R_3 can then be found by means of a db vs. current ratio table (see which in the above example would be 1.938 decibels).



To find loss due to connecting shunt resistance between resistances R_1 and R_2 substitute the resistance values in the following equation and solve to find the ratio of the current under the two conditions.

For example:

$$\frac{I_2}{I_1} = \frac{1}{1 + \left(\frac{1}{R_3} \times \frac{R_1 R_2}{R_1 + R_2}\right)}$$

$$= \frac{1}{1 + \left(\frac{1}{300} \times \frac{600 \times 600}{600 + 600}\right)} = 0.5$$

The loss in decibels due to the shunt resistance may then be found by reference to a db vs. current ratio table, which in this case shows a loss of 6 decibels.

Line Wire Splicing

Q.—What method should be used in cleaning line wire, either copper or iron, preparatory to splicing by means of sleeves?

A.—The approved method is to use a piece of medium emory cloth about 3″x5″, pressing the cloth around the wire using thumb and index finger, and sliding it back and forth until all sides of the wire are bright and clean. On iron wire care should be taken not to remove the galvanizing.

Subscribers' Card Record

Q.—Many companies, especially the larger ones, maintain subscribers' card records. Please explain the purpose of this record.

A.—The subscribers' card record consists usually of cards which are filed numerically according to telephone numbers. These cards, in addition to providing a record of the subscriber's main distributing pair terminal number, type of service and instrument, also provide space for listing each case of trouble occurring on a subscriber's line. This latter record is quite helpful in settling disputes with subscribers and also in analyzing causes of recurring trouble.

ANNOUNCE PIONEERS' DAY AT CONVENTION

The third day of the annual convention of the United States Independent Telephone association which will be held at the Stevens hotel, Chicago, October 20, 21, 22, and 23, will be Pioneers' Day, according to an announcement sent to members by J. K. Johnston, secretary.

The eleventh annual convention of the Pioneers will be held at 10 o'clock Thursday morning, October 22, at the Hotel Stevens. Business and reports will occupy the morning session which will be followed by a 1 o'clock luncheon and an entertainment.

USES TECHNICAL ARTICLES IN TELEPHONE WORK

Tulsa, Oklahoma,
July 3, 1931.

Telephone Engineering Publishing Co.,
192 North Clark St.,
Chicago, Illinois.

Dear Sirs:

In a letter of yours of May 6, 1931, you stated that my subscription to your magazine TELEPHONE ENGINEER had run out.

You will find enclosed a money order for ($3.00) three dollars, which I desire to be used for a subscription to the above magazine for two years as offered under your special rate.

I enjoy your magazine greatly, especially for the fine technical articles upon the telephone subject, and use some in my present work with the Southwestern Bell Telephone Company in this city.

Sincerely yours,

(Signed) Robert F. Forbes.

Carry An Accurate Pocket Ohmmeter For Circuit Testing Of All Kinds

JEWELL

The Jewell Pattern 89 Ohmmeter provides a simple means for quickly and accurately checking or making resistance measurements on all outside lines and central office circuits.

It is completely self-contained, very light in weight, and is easily carried in a pocket. A standard 1½ volt flashlight cell within the case provides the necessary potential. Accurate measurements are assured by a simple screw adjustment that compensates completely for any change in battery voltage.

The Jewell Pattern 89 Ohmmeter is available in single and double range models, with ranges expressly designed for telephone testing.

Write for detailed information concerning this useful instrument.

Pattern 89 Ohmmeter
Single Range

Full Size Scale, Single Range Ohmmeter

Jewell Electrical Instrument Company
1650 Walnut Street, Chicago, Illinois

THE NEW STEWART DIRECT READING TEST CABINET

Operates on eight No. 6 dry cells, and costs but $2.00 per year to operate. Installed as easy as a telephone. We furnish a mile chart that gives distance to trouble on all kinds of wire. Price $56.00 for 15-volt scale. $61.00 for 150-volt scale. Sent on trial. Write for literature.

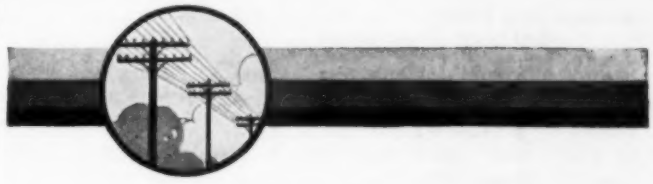
STEWART BROTHERS, Ottawa, Ill.

Cedar Poles

Northern White Western Red
Plain or Treated Butts

Prompt Shipment from Minneapolis Yard.

T. M. Partridge Lumber Co.
Minneapolis, Minn.



WIRES AND CABLES of Every Description

FOR any type of wire or cable used in Telephone, Telegraph or Power work—get in touch with "Phillips".

This company can supply you with any size, any grade or any type of wire or cable, either bare or insulated to suit your requirements.

Deliveries from this company are unusually prompt, due to the large stocks which are maintained at each of our branches, and their location at strategic points for quick shipment to any place in Canada.

Besides this you have the cooperation of a staff of experts in wire and cable manufacture, trained to value quality above all else—backed by a firm which has been in this one business for over forty years. Write for prices.

We are manufacturers of—

Bare and Insulated Copper Wires—Rubber Insulated Wires—Enameled Wire—Magnet Wire—Power Cables—Switchboard Cables—Paper Insulated Cables—Flexible Cords—Electrolytic Copper Rods, Shapes, etc.

EUGENE F. PHILLIPS ELECTRICAL WORKS, LTD.

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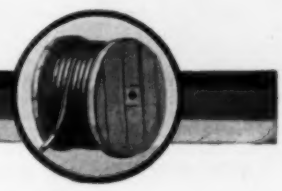
MONTREAL, CANADA

FACTORIES—MONTREAL AND BROCKVILLE
BRANCHES—WINNIPEG, TORONTO, REGINA AND VANCOUVER



SUGGESTS SIMPLIFICATION OF PHONE NUMBERS

In the belief that under the present "complicated" system of telephone exchange designations at least 120 calls out of every 1,000 are failures, Dr. A. I. Ringer of 3 West 73rd street, has formulated a new zone system for the city's telephone exchanges, which he has placed before the New York Telephone Company with the suggestion that it be adopted in place of the method now in use. Dr. Ringer explained that psychological tests made by him showed that it was almost impossible for the average telephone user to make calls under the five-numeral system without falling into error about once every eight times.

New York City and Long Island are divided geographically into six zones under Dr. Ringer's plan. Thus, Manhattan below Forty-second street is designated as "D" for downtown, while above Forty-second street it becomes "U" for uptown. Kings County, or Brooklyn, is designated as Zone "K," the Bronx is Zone "X," Staten Island "S" and Long Island "I."

Beginning with the tip of Manhattan, the first exchange under Dr. Ringer's plan would be D-1A. This combination with four figures would take the place of a designation such as Bowling Green with five figures. The other zones would be divided in the same way.

Dr. Ringer said there would be no need of any change in the present equipment of the telephone company and that the cost of installing this system would be negligible.

Group of Entertainers Who Will Present the Program Following the Annual Luncheon of the Independent Pioneer Telephone Association of the United States. Most of These Entertainers Have Appeared on Various Programs of the National Broadcasting Co.

ELDRIDGE TO VENTURE FORTH TO ANOTHER CONVENTION

Frank L. Eldridge isn't easily discouraged. In spite of the fact that he returned home from the last telephone convention he attended with three fractures in his spine and a broken ankle, he plans to be present day and night during the four days of the United States Independent Telephone Association convention in Chicago. The above injuries were sustained the first week in June when he walked through the wrong door and fell down the elevator shaft in a hotel at Abilene, Kans.

Mr. Eldridge, who is head of the Frank L. Eldridge company, national distributors for the French Battery company and the Do/More Chair company, will collaborate with both concerns in their display booths for the national convention. He will also have a room at the Stevens Hotel, headquarters for the convention. Undoubtedly many of Mr. Eldridge's friends over the country will welcome this opportunity to congratulate him upon his swift recovery.

Although doctors and insurance companies predicted at least six months of convalescence following the accident, a lapse of only four months now finds Mr. Eldridge sufficiently recovered to spend at least part of every business day at his office, 11 South La Salle street, Chicago.

WESTINGHOUSE ANNOUNCES DIVIDENDS

After the meeting of the board of directors of the Westinghouse Electric and Manufacturing company held recently, A. W. Robertson, chairman, made the following announcement:

"The board declared a dividend of 1¼ per cent, amounting to 62½c per share, on both common and preferred shares (payable October 31, 1931, to stockholders of record September 30, 1931), payment of which will make a total of 7¼ per cent paid this year on the par value of both classes of stock, which compares with 10 per cent paid in 1930."

DOES NOT WANT TO MISS A COPY OF "ENGINEER"

McLennan, Alta.

TELEPHONE ENGINEER,
Chicago, Ill.

Dear Sirs: Please change my address from Sedgewick to McLennan, Alta. I thoroughly enjoy your paper and do not want to miss a copy.

H. J. Bowman.

.....Send for Free.....

Specification Blanks

on

Re-manufacturing Your Old Telephones

Every telephone company has on hand obsolete and old-style telephones and parts, which can be re-manufactured into modern telephones that both look and give service like brand new telephones.

Suttle Telephone Re-manufacturing Service consists of repairing and rebuilding your old parts, and installing them in new cabinets or refinished metal cabinets with necessary new parts so that you have a brand new telephone. The service is thorough and complete, and the telephone delivered to you is guaranteed to be equal to any brand new telephone you can buy, both as regards talking efficiency and appearance. They are delivered packed in separate cartons.

You Make Your Own Specifications

You are furnished a set of specification blanks on which you specify just exactly how you want your telephones re-manufactured. You specify the kind of cabinets you want, the finish on metal parts, the wiring, any special features you want, and other details of construction. The blanks furnished have full information to help you decide on all details. You are given a definite quotation on the total cost when these specifications are submitted to us. Average costs will run from $5.00 to $8.00.

At Least Investigate This Service

While you may not be needing telephones right now, you should at least find out what it will cost you to re-manufacture the useless equipment you now have on hand. Use the coupon below for free blanks on which you can submit specifications and get a definite quotation. Then you can decide when you need new telephones.

Suttle Equipment Co.
FACTORY AND MAIN OFFICE
Lawrenceville, Illinois

INVESTIGATION COUPON

Date.....

SUTTLE EQUIPMENT CO.,
Lawrenceville, Ill.

Please send me a triplicate set of specifications for re-manufacturing telephones. I will fill them in and return for quotations. I understand there is no obligation to me whatever.

Company .....

Address .....

Manager .....

YOU CANNOT LOSE

Most every telephone man knows about the Coffey System-Central Accounting Department—many have been using it for years. If you don't know how it can save you money and place your accounting second to none, write today for particulars.

Heretofore, the drawback to the smaller Company was the expense of getting started, but we have now arranged to handle this without expense to you, and your charge begins only after we have actually turned out your first month's statement. If at the end of the first year you are not satisfied, all records are returned in an up-to-date condition.

The Chairman of the Indiana Public Service Commission said, "It would seem to me that you have not made your Central Accounting scheme plain, or the building you are in would not be large enough to handle the business."

It costs you nothing for full particulars and it will be our pleasure to furnish them.

COFFEY SYSTEM & AUDIT CO.
Consolidated Bldg.
Indianapolis Indiana

Insure Your Overhead Lines

BY SPECIFYING

MacGillis

NORTHERN or WESTERN

CEDAR POLES

PLAIN or BUTT-TREATED

FROM

120 E. Wisconsin Avenue

THE MacGILLIS & GIBBS CO.

MILWAUKEE - WISCONSIN

With Manufacturers and Jobbers

ZMA TREATMENT FOR WOOD DESCRIBED

An interesting bulletin describing the ZMA treatment for wood preservation has been issued by the Curtin-Howe corporation, timber preservative engineers, 405 Lexington avenue, New York City.

With this pressure treatment, two natural enemies of lumber, decay and destruction by insects, are eliminated and the lumber can be used for all kinds of permanent construction, according to the bulletin. The ZMA treatment also gives lumber the added advantage of being slightly fire-resistant, the bulletin says.

Among the permanent uses of ZMA treated lumber, painted or unpainted, described and illustrated in the bulletin, are poles for transformer installations.

KESTER OPENS CANADIAN PLANT

Kester Solder company, originators of self-fluxing solder, announces the establishing and opening of a plant at Brantford, Canada, on September 15. The plant will be operated under the name of Kester Solder Company of Canada, Limited.

The obvious growth of Canadian business, both as to industry and general consumption, caused the Kester Solder company to establish this new plant. This newest member of Kester plants increases the number to three strategically located manufacturing sources; namely Chicago, Newark, N. J., and now the Brantford plant for Canada.

F. C. Engelhart, president of the Kester Solder company, commented as follows concerning the Brantford plant, "As with the establishing of our Newark plant, it is our desire to give our customers the best service possible. Canada could not be efficiently served without a plant located in the Dominion. Our three plants enable us to produce economically and expedite service. Kester leads the field in solder—this new plant still further establishes Kester's reputation for leadership."

"Kester sales are ahead of last year," says J. A. Reitzel, general sales manager of Kester. "The fact is attributed to an even more aggressive merchandising effort on the part of both Kester as the manufacturer and our distributors. Canadian sales possibilities seem exceptionally bright because of Kester's already strong position and promise of more ready sales now the Canadian plant is in operation."

The Kester Solder company manufactures a complete line of solders including Kester Acid-Core, Plastic Rosin-Core, Paste-Core, Kester Metal Mender, Kester Radio Solder, Body Solders, Solid Wire and Bar Solders and Specials. All of these products will be manufactured in the Brantford plant.

BECOMES ASST. MANAGER OF KANSAS CITY BRANCH

A. B. Preble, Stromberg-Carlson representative in the Rocky Mountain territory, has just been appointed assistant manager of the Stromberg-Carlson Kansas City branch, according to announcement by G. A. Scoville, vice-president and sales manager.

Mr. Preble has represented Stromberg-Carlson in the western territory for several years and his host of friends will be glad to hear of his appointment to this important post.

He started in telephone work while he was still in school, repairing switchboard cords and changing batteries for his father, John W. Preble, superintendent

Mr. A. B. Preble, Assistant Manager of the Stromberg-Carlson Kansas City Branch.

of the Phoenix Telephone company of Steubenville, Ohio.

In 1908 he received a full-time position with that company and when it was purchased by the National Telephone company of Wheeling, W. Va., a short time after, he remained as troubleman and lineman and later was promoted to wire chief of the Steubenville exchange.

In 1913 Mr. Preble went to Canton, Ohio, as wire chief of the Canton exchange of the Ohio State Telephone company. Two years later he became associated with the Garford Manufacturing company of Elyria, Ohio, as installer. In this position his first job was the installation of equipment in the West 25th street office in Cleveland, followed by the installation of toll switchboards at Youngstown and Alliance, Ohio.

When the Stromberg-Carlson company and the Garford company merged in 1918, Mr. Preble became associated with the Kansas City branch as salesman in the state of Missouri. After six months in Missouri he was transferred to the Nebraska territory which he covered for six years. At the end of that period he was transferred to the Kansas City office as specialty salesman for radio equipment.

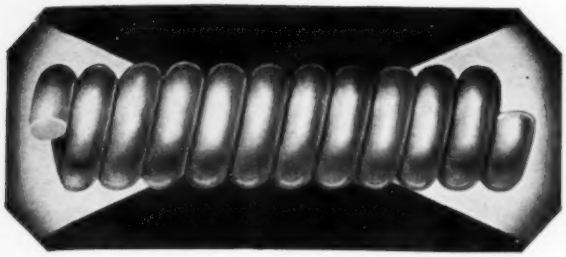
On September 1, 1926, he took over the Rocky Mountain territory comprising the states of New Mexico, Colorado, Wyoming, Montana and Utah. Mr. Preble covered this territory up to the time he was appointed to his present position as assistant manager of the Kansas City branch.

PEDLEY SELLING S. P. A. TRUCKS

W. S. Pedley, former sales manager of the Highway Trailer company, Edgerton, Wis., severed his connection with that organization on September 15 and is now in charge of sales of the public utilities division of the Studebaker-Pierce Arrow Truck corporation.

Mr. Pedley has held responsible positions with firms calling upon telephone managers throughout the country for a number of years and has an extensive acquaintance in this utility field. He will make his headquarters in Chicago and is located at Michigan avenue and 26th street.

Mr. W. S. Pedley, now connected with the Studebaker-Pierce Arrow Truck Corporation.



Galvanized Telephone Wire and Steel Strand

Crapo Galvanized Wire can be wrapped around its own diameter without injury to its pure zinc coating....That is one of a number of reasons why **Crapo** Galvanized Telephone Wire and Strand can be depended upon to reduce maintenance cost.

Look for the **Crapo** Seal!

Indiana Steel & Wire Co.
Muncie, Indiana

Crapo
GALVANIZED PRODUCTS

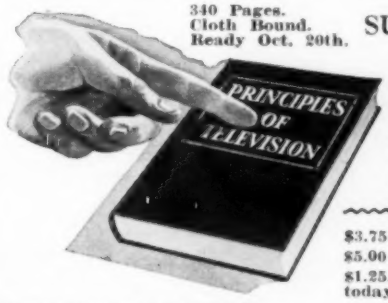
YOUR FUTURE DEPENDS ON TELEVISION

YOU want this book!

TELEVISION EXPLAINED...*fully*

...*by The Inventor Himself*

All of your engineering problems answered. "PRINCIPLES OF TELEVISION", by Farnsworth and Halloran, is the engineer's guide to all television engineering. A complete course of instruction in Television . . . all in one volume.



340 Pages. Cloth Bound. Ready Oct. 20th.

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Those who order now will receive a 6 month supplement service without extra cost. This keeps the book up to date.

$3.75 if you order now. $5.00 if you wait. Save $1.25. Send coupon today.

TELEPHONE ENGINEER
185 N. Wabash Ave., Chicago, Ill.

Here is $3.75 for 1 copy of "PRINCIPLES OF TELEVISION" and the 6 months' supplement service.

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Address .....

Reduce Your Ringing Cost

Size 12"x9"x5"
Weight 15-lbs.

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ONE CONTACT!

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THE SUPER-RINGING MACHINE MEETS ALL THE REQUIREMENTS OF GOOD RINGING SERVICE

While at the Convention, don't neglect to give TELERING some of your time. You'll not regret it.

Suitable for the largest Central Office or the smallest P. B. X.

POSITIVELY NO RADIO INTERFERENCE

OPERATED BY COMMERCIAL ALTERNATING CURRENT

Trial Orders Invited

Fully Guaranteed

Price $44.00 F. O. B. ELYRIA, OHIO

Sold by Leading Telephone Distributors

TELKOR, Inc. . . ELYRIA, OHIO

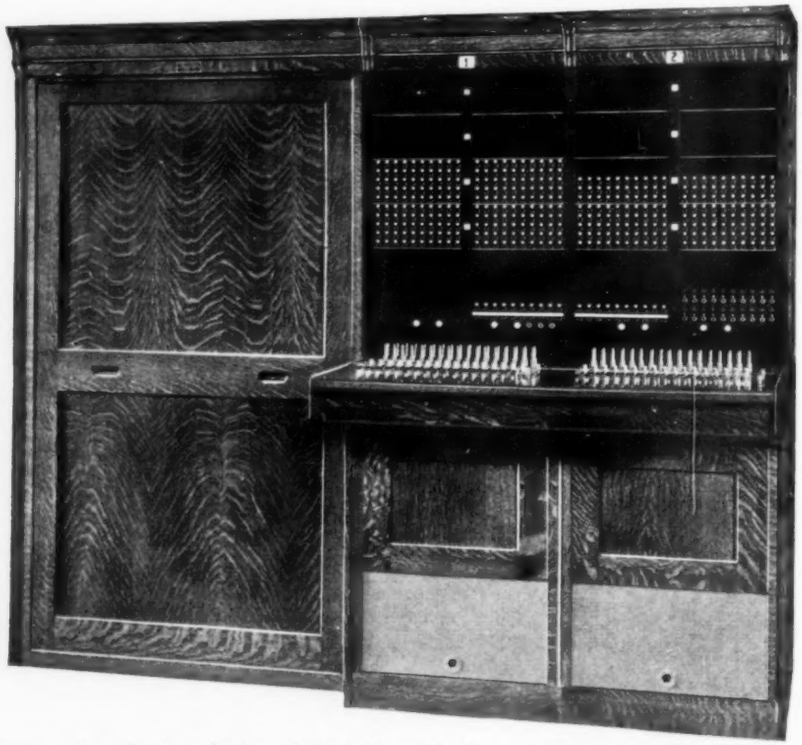
WEST IOWA TELEPHONE CO. INSTALLS NEW KELLOGG SWITCHBOARD

It cost the West Iowa Telephone company a good $24,000 to rebuild their Marcus exchange, and to replace the central office equipment. And was it worth it? Well—just ask their subscribers in Marcus, or ask Mr. Reimers, the central manager, how many phones he installed for new customers.

Back in 1917, H. J. Reimers bought the Marcus, Iowa, exchange from Frank Barnes. Ten years later, after he had built up the company into a sound, profitable business, rendering consistently good service, he consolidated with the Remsen, Alton-Granville Telephone company. A short time later, he helped organize the West Iowa Telephone company, with T. E. Closster, president; W. H. Daubendick, secretary and treasurer; and Mr. Reimers, general manager. The general office is in Remsen, Iowa, one of the company's six exchanges.

Marcus, a town of 1,100 population, is in Cherokee county, the center of a rich farming community. When the need for better service was realized, the company made arrangements to rebuild its entire Marcus system. The first step was to construct a new one-story building to house the central office equipment. The structure itself is a modern, well-lighted building with the surrounding ground attractively landscaped.

A new Kellogg two-position Universal board was installed to replace the magneto central office equipment previously used. The Kellogg board is arranged for an utlimate capacity of 800 local lines. At present it is wired and equipped for two operators' positions and 300 common battery local lines. It is also wired for forty magneto rural lines and equipped with thirty. For toll, there are twenty lines wired and ten equipped. The board has Universal cord circuits equipped with the latest type of repeating coils and condensers. With the installation of the new equipment, the service has been greatly improved both as to speed and transmission. Marcus has been especially favored in having service excelling that of many large cities. The company has been steadily progressing during the past years because it fully appreciates the necessity of rendering good service to the public.



Kellogg Two-Position Universal Switchboard having an ultimate capacity of 800 local lines of the type installed at the Marcus, Iowa, Exchange of West Iowa Telephone Company.

VACUUM TUBE THEORY

(*Continued from Page 20*)

is necessary to take into account the absorption due to the presence of the audience.

Inasmuch as a value of 4.7 units is assigned per person it is apparent that the period of reverberation would be much lower in an auditorium that was filled than in one that was empty or only partially filled.

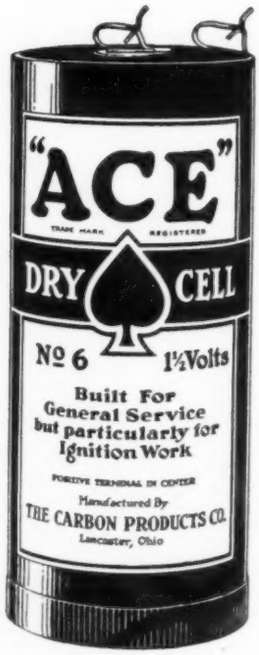
The engineer concerned with public address work is not called on to compute the period of reverberation for each inside installation, and the foregoing data is given mainly to call attention to the effect of the acoustics of a building on sound projection.

The experienced sound man can tell fairly well whether the acoustics of a building are satisfactory by merely clapping his hands and listening to the resulting reverberation.

In cases of large public address installations either of a permanent or temporary nature it is often desirable to compute the "period" especially when it is suspected that the acoustics may be bad.

Note.—Next month's article will discuss the theory and application of public address amplifiers and pick-up microphones.

Outstanding Performance



Precision in their manufacture makes Ace and Victor most uniform.

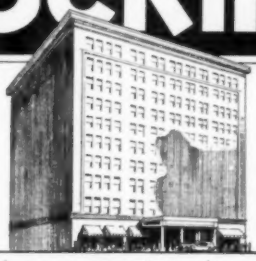
This uniformity, plus the high standard of their ingredients and laboratory control, assure greater Dry Cell Dependability and longer Dry Cell Life.

Specify Them Always

Bond Electric Corp.
JERSEY CITY

Chicago Lancaster San Francisco

HUCKINS



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JOSEPH HUCKINS JR.
MANAGING DIRECTOR

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OXFORD HOTEL ENID, OKLA.

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FOR TELEPHONE MEN

HOTEL SHERMAN

DRIVE Your Car Right into Hotel Sherman

Single Room with Bath $3.00 a day and up

Double Room with Bath $4.00 a day and up

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CHICAGO'S NEWEST DOWNTOWN HOTEL

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RADIO IN EVERY ROOM

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DIRECT ENTRANCE FROM HOTEL TO HARRISON PARKING GARAGE

HARRISON STREET JUST OFF MICHIGAN BOULEVARD

CHICAGO

STEWART BROS. INTRODUCE MIDGET INSTRUMENTS

Due to demand for a pocket size instrument, Stewart Brothers, Ottawa, Ill., makers of testing instruments, have discontinued manufacture of their Detecto-Meter as it was constructed, and are bringing out a pocket size model.

This instrument is a voltmeter and ohmmeter with a scale reading from 0 to 10,000 ohms, and is made in two ranges of voltage, namely 0 to 3 volts and 0 to 60 volts.

This Detecto-Meter is designed to be used for all kinds of resistance work, such as locating defective joints and connections in telephone and telegraph lines.

With the midget Detecto-Meter all kinds of transmitter, receiver, bell or generator trouble in magneto telephones can be located. Also resistance of transformers and retardation coils, or choke coils, can be measured in any piece of apparatus.

Stewart Brothers are also bringing out a midget tone set, pocket size, for cablemen. It is complete with batteries and condenser in the circuit and can be used by those wanting a continuous tone for testing purposes. It is also a buzzer test set for buzzing through wiring, or to test out any circuit.

COMMON BATTERY SERVICE FOR MENDHAM

A new common battery telephone service has been installed in Mendham, N. J., replacing the old magneto system. About 365 telephones were affected. Mayor Charles H. Day of Mendham gave the signal for the start of the telephone service from the new common battery central office during the recent cut-over.

SET DATE FOR MISSOURI CONVENTION

The Missouri Telephone association will hold its annual convention Wednesday and Thursday, November 11 and 12, at the Hotel President, Kansas City.

FOR SALE

This month only. Brand new three conductor brown desk stand cords, $15.00 per hundred. Also brand new Bakelite mouthpieces for W. E. transmitters. $5.00 per hundred.

W. M. Miller & Sons,
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RECONSTRUCTED EQUIPMENT

Kellogg No. 2696 type 4-bar 1000-1600 or 2500 ohm Bdg. compacts, $8.50—lots of 10 @ each	$8.00
Chicago Tel. Supply Co. 12-bar 1000-1600 or 2500 ohm compacts @ $6.75—lots of 10 @ each	6.25
Chicago Tel. Supply Co. 15-bar 1000-1600 or 2500 ohm compacts @ $7.50—lots of 10 @ each	7.00
Kellogg No. 97 C. B. desk set with No. 259 Straight line signal set @ each	7.00
Kellogg No. 118 C. B. desk set with No. 259 Straight line signal set @ each	7.00
Kellogg No. 28 Cast head desk set with Stromberg inside cord connection, 4-bar 1000 or 1600 ohm signal set @ each	8.75
Kellogg No. 28 Cast head desk set with W. E. No. 240 external post connection, 3-bar 1000-1600 or 2500 ohm signal set @	8.00
Western Elec. No. 240 3-bar 1000 or 1600 ohm Bdg. hotel sets @	5.00
Western Elec. No. 317 3-bar 1000 ohm Bdg. compacts with 3-inch gong ringers @ $6.60—lots of 10 @ each	6.30
Western Elec. No. 22 3-bar Bdg. Generator with crank and screws @	1.60
Monarch Local Battery Ind. Coils @	.35
Stromberg-Carlson Local Battery Transmitters with back @	.85
Monarch Local Battery Transmitters with back @	.85
Western Elec. No. 315 3-bar 1000-1600 or 2500 ohm desk set signal sets with No. 13 Ind. Coil @	5.35
Kellogg No. 259 Steel bell box with Straight line ringer equipped with No. 79 Booster coil @	3.00

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Twenty Years Successful Operation of this Department in connection with our business puts it past the experimental state—Quality and Price have made our customers permanent—it will pay YOU to investigate.

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Magneto Equipment

W-E Compacts, 1000 ohm 3-4-Bar, ...$5.00 Each
Kellogg Compacts, 1000 ohm, 3-4-Bar .....$5.00 Each
Monarch Compacts, same as above, ... $4.00 Each
Stromberg Compacts, same as above, ... $5.00 Each

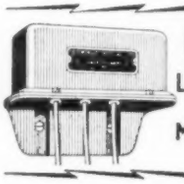
Parts for all makes **Cheap**
Generators, 30c; Cranks, 5c; Induction Coils, 10c; Harmonic Ringers, 25c; Direct Ringers, 30c; Gongs, 2c; Receiver Hooks, 25c; Receivers, 50c; 1 MF Condensers, 15c; Transmitters, 50c.
Transmitter Brackets, 10c.
1 No. 74 Leich Converter, for harmonic (4-party) ringing, almost new..$35.00
10 to 250 Volt Jewel Voltmeter..$5.00

Western Telephone Repair Co., 1016 Yale Ave., St. Louis, Mo.

FOR SALE

Slightly used twisted drop-wire, 200 to 800 foot lengths. $30.00 per ton.

W. M. Miller & Sons,
2553 Madison St., Chicago, Ill.



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Plugs to replace Kellogg No. 42	$ .75
Plugs to replace Kellogg No. 106	.90
Plugs to replace Kellogg No. 201	.90
Plugs to replace W. E. Co. No. 47	.75
Plugs to replace W. E. Co. No. 110	.90
Plugs to replace S. C. Co. No. 42	.75
Plugs to replace S. C. Co. No. 53	.90

—Standard Insulation Plugs (new)

W. E. Co. No. 109	$ .90
Kellogg No. 74 and No. 116	.90
W. E. Co. No. 137 operators' plugs	1.50

Buckeye Telephone & Supply Company
Columbus, Ohio